TOPICS OF THE MONTH

Producing chemicals in nuclear reactors

ONE of the most interesting subjects discussed at the recent International Conference on the Peaceful Uses of Atomic Energy, held at Geneva, was the possibility of direct chemical production in nuclear reactors, making use of fission recoil fragment energy. Some 84% of the total fission energy release is then potentially available for use in chemical synthesis. This energy is in the form of kinetic energy which is rapidly lost by interaction with surrounding matter. In the conventional fuel element, the energy ultimately appears as high-grade heat and it is then converted into electricity by a relatively inefficient process.

While it has been shown that the maximum amount of reactor heat energy which might be converted directly into chemical energy is only about $1\frac{1}{2}\%$, this figure being small compared with the energy efficiency of about 30% for chemical production using coal as a direct energy source, the advantage of the nuclear route is that the remaining $98\frac{1}{2}\%$ should be still available for electricity production in the normal way. Since high rates of production may be found possible in nuclear reactors, there is the possibility of very substantial savings in coal (or oil) consumption which would have been used to produce the chemicals by the normal route. The low energy efficiency must be offset by the simultaneous production of electricity in the same reactors.

These were among the points brought out in the paper by J. K. Dawson, G. Long, F. Moseley and R. G. Sowden (all of the U.K.A.E.A. Atomic Energy Research Establishment, Harwell), in which a pressure-tube design of the heavy-water-moderated, gas-cooled reactor system was suggested as being suitable for radiation-induced gas-phase reactions. It would be necessary to replace the conventional fuel elements by a gas-fluidised slurry of small-diameter particles.

One of the most serious problems of this type of reactor would be fission product radioactivity in the chemical products. Rather high decontamination factors are involved but it seems reasonable to assume that they could be achieved by distillation processes.

Preliminary experimental work has shown values of G up to 0.9 at atmospheric pressure and 80°C. for the production of NO_2 from nitrogen/oxygen mixtures. (G is the normal method of expressing yield in a radiation chemical process, being the number of molecules of product formed by the absorption of 100 ev. of energy.) To compete economically with the conventional process for nitric-acid production it will probably be necessary for G to be at least 10 at about 500°C. and 30 to 40 atm.

The experimental work on the chemical effects of fission fragments has been very limited hitherto, but further work may discover attractive chemical syntheses which would be either very difficult or impossible to achieve in any other way.

Chemical engineers in the U.S.S.R.

THE large and increasing numbers of engineers and technologists that are being turned out in the Soviet Union has been the subject of recent comment both in Europe and the U.S.A., while in Britain it has been pointed out that the educational system must show a change of attitude towards technology, the outmoded bias towards the arts being dropped. That no such bias hinders the Soviet educational system is evident from recent reports which indicate that, on the contrary, technology is held in the highest esteem in the U.S.S.R. and Soviet engineers are given every incentive, both financial and otherwise (see CHEMICAL & PROCESS ENGINEERING, 1957, **38** (4), 129). There is no doubt that, in the U.S.S.R., industry and technological progress are glorified to an extent which makes a sharp contrast with the scant publicity given to industrial and technological matters in Britain. While some features of the Soviet attitude might be considered undesirable in a balanced community, it certainly gets results, having the effect of attracting a considerable proportion of the student community, including women, to the technical professions.

It is against this background that the place of the chemical engineer in the Soviet Union must be seen, and an American observer, Mr. J. G. Tolpin of the Standard Oil Co. (Indiana), has recently given an illuminating picture of how Soviet chemical engineers are trained and used. He points out in the August issue of *Chemical & Engineering Progress* that the proportion of chemical engineers in the Soviet engineering profession which existed at the end of World War 2—11%—has probably not decreased, judging from the rate of growth of the Soviet chemical industry, while a modest estimate of 7% of chemical engineers in the U.S. engineering profession seems to be justified.

A Russian engineer has to go through a five-year period of study after graduating from a secondary school, being also obliged to pass a competitive examination before admission to a university or technical college, the examination results being published in most important newspapers. A technical college student takes a prescribed set of courses in which he has no option and has to pass a series of examinations.

The permanent teaching staff of technical institutes and universities is expected to possess a doctor's degree. The total number of professors with advanced degrees amounted, in 1956, to 45%.

Mr. Tolpin points out that drastic steps have been taken in the U.S.S.R. to counteract overspecialisation of engineers. Professional training, divided into 24 specialities and at one time into a total of 454 sub-specialities, was reduced by 1954 to 295 sub-specialities, including 56 sub-specialities of engineering training for service in the chemical and chemical process industries. The programme of study in chemical engineering includes not only general chemical technology, pro-

cesses and equipment for chemical industries, and corrosion of metals, but also automation of chemical plants and safety techniques. In addition to formal courses, a Soviet student of engineering acquires up to six months' plant experience in the course of his study. Research work or plant designs are required for graduation and, as a rule, problems are treated in these researches constituting a part of an actual problem faced by the given industry. The training of an engineer is completed when he passes written and public oral examinations.

Notwithstanding the generally improving training of Soviet engineers and their growing reliance on their own researches and supporting services, including technical information, the industrial development of Russia lacks uniformity and the Soviet engineer still experiences difficulties in translating laboratory data into an economical process, especially when he encounters problems unprecedented in other countries. There is evidence that Russian engineers have not taken full advantage of a number of processes from which their economy could benefit. The oil-refining and chemical industries offer such examples.

Frequently the chemical engineer must obtain collaboration from individuals belonging to different social and governmental groups and considerable appropriations and materials allocations. He encounters ideological relationships unprecedented in other societies. Process design involves delays in the commercialisation of research in other countries also, but in Russia the lag is much greater and constantly occupies the attention of leaders of research and industry. Leaders of research publicly complain of delays that show that pilot-plant work and process designs are still the weak links. Mr. Tolpin concludes that the smaller experience in pilot-plant work and in process design and the social and the ideological difficulties in bringing a process to fruition serve perhaps as the greatest deterrent to much industrial development in Russia today.

'Hydro-cracking' in Hungary

RESEARCH aimed at the further development of Varga's method of hydro-cracking has been reported from Hungary. Formerly, white products (petrol, fuel oil) had to be obtained from bituminous and sulphurous oils as well as from lignite tar at a very high cost. The hydro-cracking process necissitated a pressure of 700 atm., a temperature of 490°C. and—this made the process particularly expensive—plenty of pure nitrogen, as well as equipment made in a special alloy. The new method needs a pressure of only 70 atm. and a temperature of only 430 to 440°C., while the consumption of hydrogen has been reduced to one third of the quantity formerly needed.

Results obtained in the laboratory and in the experimental station of Pécs have been fully justified in large-scale manufacture in Böhlen, East Germany, where additional advantages of the new process have come to light. Thus, according to the Hungarian Chamber of Commerce, Varga's method has been applied effectively in extracting petrol and fuel oil, also from lignite tar. With the other methods formerly applied, it is stated, poor-quality materials (oil, tar) had to be hydrogenated first, after which sulphur still present in it would be removed by means of special equipment. In the new method, however, both operations are performed simultaneously, thus allowing good-quality desulphurised products to be extracted from poor-quality materials.

Experiments are being continued with imported oil and tar.

Not just for art's sake

'AND what's this?' inquired the visitor, pointing to a drawing of what appeared to be the latest thing in intercontinental ballistic missiles.

'Ah now, that!' said the chemical engineer enthusiastically. 'That's our design for a new reactor.'

'Really?' said the visitor. 'Will it work?'

'No,' said the chemical engineer, 'but isn't it beautiful?'

This hypothetical conversation shows the sort of thing that would happen if plant designers were to place aesthetic considerations above all others. All the same, it is a fairly generally accepted fact that simplicity and beauty of line, as has been demonstrated in the aircraft, motor-car and building industries, for example, has a definite bearing on functional efficiency. Most designers of plant and equipment are aware that a crude design is generally an inefficient one, and take this fact into account, either consciously or subconsciously, in their work.

Is there anything to be gained from giving the subject closer study? To put the question more broadly: if industry pays more attention to beauty, will it yield dividends in the form of greater efficiency?

No industrial manager or engineer with his feet on the ground and an eye on his budget is likely to be persuaded that there is anything to be gained from letting aesthetic considerations sway his practical judgment. To take a simple example, the average industrialist is aware that an unimaginative storage shed of corrugated iron or asbestos is not the most graceful feature of the works landscape, but it happens to be the cheapest and most practical solution to the immediate problem and does the job as well as would any impressive structure in some other material.

However, in the field of machinery and equipment, there seems to be some case for a closer study of the relationship between aesthetic design and functional efficiency. Thus, in designing a piece of chemical plant, say a cylindrical vessel with branch connections, the designer will be aware that the more gracefully the branch pipes join on to the main vessel, the stronger and less subject to corrosion problems the connecting points are likely to be. Similar considerations apply where there are elbow bends in pipelines. The limiting factor is the fabricating techniques which can be applied to the material of construction being used.

One material which often lends itself to smoother and simpler design is plastics, and Monsieur G. Fabre pointed out at a recent conference organised by the Institut d'Esthétique Industrielle in France that,

owing to the techniques by which they are formed, curves dominate in plastics constructions while sharp angles are rarely tolerated. This is a good thing because sharp corners are often points of weakness, like abrupt discontinuities in the surface. Features which are faults from the aesthetic point of view, M. Fabre argues, almost always coincide with design faults.

All this would seem to suggest that the engineer-designer of the future, given plastics and no doubt even newer materials to work on, might well draw his inspiration as much from Henry Moore and Picasso as from the laws of fluid flow and thermodynamics. The pity of it is that, in chemical plant, the most elegant components, such as mixer blades, distillation packings, evaporator coils, etc., are usually hidden from view. The problem could be overcome, of course, by the extensive use of glass or transparent plastic; all we should need would be some beautiful raw materials.

REDUCED SUBSCRIPTION RATES FOR 'CPE'

BIGGER and better than ever, and containing a greater variety of articles and features than any other comparable British journal in this field, CHEMICAL & PROCESS ENGINEERING *will now cost readers 40% less than hitherto. The annual subscription has been reduced from £2 10s. to £1 10s., while a three-years subscription costs only £3 15s., which works out at less than 2s. per copy.*

With a recent increase in the number of editorial pages, constant efforts to commission only first-class, practical contributions, and the steady introduction of more and more useful features, such as its monthly chemical plant cost indices, nomograms, its quarterly survey of 'The American Scene,' and its regular reader-service feature 'What's News About Plant, Equipment, Materials and Processes,' C.P.E. continues to hold its place as one of the most practical and informative of illustrated journals.

The reduced subscription rates will be of particular interest to those readers who at present are obliged to share a copy with others in their company or organisation, and we hope they will now be encouraged to take out a subscription for a personal copy.

Reduced subscription rates for 11 other journals of the Leonard Hill Technical Group have also been announced by Mr. W. Leonard Hill, chairman of the Group, who states that these reductions have been made possible by a general increase in circulations. The cuts have been made to encourage the widest possible dissemination of technical information, an objective of vital and ever-increasing importance today. All but one of the 15 Leonard Hill journals are technical, covering such fields as nuclear energy, automation, chemicals, pharmaceuticals, paint, petroleum, fibres, building materials, civil engineering, food and agriculture. A person subscribing to all 12 journals affected by the new subscriptions would find his total bill cut by £10 15s.

Cheaper route to heavy water?

THE new British method of producing heavy water will, if it proves to be all that is claimed, provide serious competition for the American heavy-water process which has dominated the scene up to the present. Constructors John Brown Ltd., who developed the new method, state that, although the broad principles of extracting heavy hydrogen from ammonia synthesis gas by ammonia exchange have been known for some time, the new route discovered by their research department enables costs to be reduced considerably, to below the price at present asked by the United States Atomic Energy Commission. Until now, as a result of large-scale production, the U.S.A.E.C. has been able to sell heavy water at $28/lb.—a price which made it uneconomical for most countries to produce their own. The new British technique is expected to have considerable attraction for smaller countries with atomic energy programmes.

Process details revealed at the recent Geneva atomic energy exhibition show that the extraction of deuterium from ammonia synthesis gas and the first stage of concentration to 23 times natural are accomplished by the ammonia-hydrogen exchange process. Further concentration to 75% D/H is by ammonia distillation, while final purification is by the distillation of water in a Kuhn column. The distillation section consists of nine columns, the first seven of which are in cascade. *Spraypak* is used for column packing.

As a rough guide to costs, C.J.B. say that the capital cost of such a plant will be in the region of £80,000 per *tonne* of heavy water produced p.a., depending on local conditions. Operating costs depend on power and steam costs, but £4 to £5 per kg., it is stated, covers most cases. In representative European conditions with 15% to cover interest on capital and depreciation plus £5/kg. for operation the cost of heavy water would be around £17/kg.

Using waste heat from coke quenching

THE survey of new gas-manufacturing techniques by Mr. A. R. Myhill, which began in our September issue and will conclude in our November issue, shows that much thought has gone into the improvement of such techniques in recent years. One operation carried out in both the gas and coking industries, however, seems sadly out of step with the latest carbonising techniques; this is the quenching of the hot coke immediately after it is discharged from the retorts or coke ovens, to prevent it from burning in the atmosphere. The general practice is to use 'wet' quenching, which involves the loss of very great amounts of heat, and also requires a substantial quantity of water. It has been estimated that in a plant producing 3,000 tons/day of coke, the heat lost by wet quenching would suffice to run an electric generating station of 7,500 kw. Another disadvantage is that the abrupt cooling from a temperature in the neighbourhood of 1,000°C. causes the single pieces of coke to crack, sometimes only superficially, sometimes through the centre. This leads to an undesirable increase in the quantity of breeze or dust produced.

Among alternative ideas for the cooling of coke is the use of inert gases as a medium of heat transfer. In such a system, the sensible heat contained in the incandescent coke is carried by the inert gases to a heat exchanger, which may take the form of some sort of boiler or preheater, and may also serve as a main heat producer or as a preheater stage for an open or closed gas- or air-turbine cycle.

Recent progress in the recovery of heat from coke by this means is reviewed in a recent publication of Sulzer Bros., Switzerland, where it is maintained that some 235,000 Kcal. of useful heat, after deduction of all losses, can be recovered per ton of coke with the dry-cooling process. It is pointed out that the heat losses per ton of coke produced, on the basis of the fuel consumption of the ovens, are accordingly not 26 to 17% as with wet quenching, but only about 9 to 5%.

There are three types of Sulzer dry coke-cooling plants, the bunker, chamber and fine-tube types, which differ in the design of the cooling spaces and to some extent in their operating features. The principle of heat exchange is common to all three, a slight modification being apparent in the fire-tube type, which is only suitable for small gasworks. Large plants may well handle as much as several thousand tons of coke per day.

Plants such as this have been put to use for preheating the combustion air of oven-firing systems, boiler feedwater, or even the coke-cooling plant itself. Where very little of the heat recovered from the coke can be put to direct use, it can be used instead for generating electricity. Until recently, steam turbines were the only machines adopted for this duty, but interesting combinations of dry coke-cooling plants with gas or hot-air turbines are now possible.

This method of cooling coke seems to have found particular favour in Switzerland, where, it is reported, ' wet ' quenching has already become a rare exception.

Commercial separation of phosphonitrilic polymers

A NOTABLE advance in the field of polymer chemistry is announced from the research laboratories of Albright & Wilson where, resulting from the success of the initial stages of research into the nature and properties of phosphonitrilic chlorides, it has become commercially practicable to separate the trimer and the tetramer from the crude mixture of cyclic and linear polymers. The company, who claim to be the world's first chemical manufacturing company to announce that they can separate the polymers on a commercial scale, say that sample quantities of pure trimer and tetramer are already available and that greater quantities will be available shortly.

In recent years the phosphonitrilic series of inorganic polymers has attracted increasing attention from research chemists. This has been largely due to the demand for high-temperature-resisting materials, typified by the recent spurt in both rocket and ' space ' research. The phosphonitrilic compounds have several similarities to silicones—of which Albright & Wilson pioneered manufacture in the United Kingdom —and the company are hopeful that a wide range of heat-resistant materials, in addition to other products, will be developed from them.

Chemical expansion in Poland

A HIGH rate of development is being maintained in Poland's chemical industry, the output of which, under the current five-year plan, is expected by 1960 to be more than double the figure achieved in 1955—when Poland advanced to the eighth place among world producers of chemicals. Production figures show a rapid rise in recent years; thus, from 1949 to 1957 the output of sulphuric acid increased by 80%; calcined soda by 92.4%; caustic soda, more than 100%; while chlorine production rose over 500%. Output of synthetic ammonia and carbide also showed a slight rise.

Considerable investments have prepared the way for the production of synthetic organic chemicals from acetylene and coal-tar semi-products. A number of semi-products important to industry — methanol, phenol, acetic acid, etc.—are being produced in Poland for the first time. It is anticipated that the organic synthesis industry will develop more rapidly than any other branch of the Polish chemical industry, and will supply semi-products necessary to the further development of the synthetic fibre industry as well as to new branches of industry concerned with the production of plastics, synthetic rubber, and synthetic washing agents.

Fertiliser production is also marked for an increase. Production of nitrogenous fertilisers is expected to reach nearly 300,000 tons by 1960, as against 175,000 in 1956, while the output of phosphorous fertilisers is to rise, over the same period, from 129,000 to 229,000 tons.

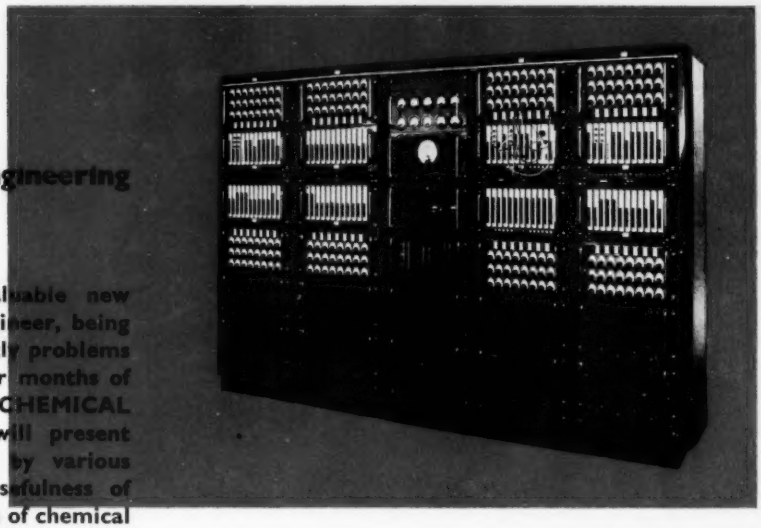
A distinct change of policy resulting in a stepping-up of exports has been a feature of the Polish chemical industry in the past few years, and the total value of exports in 1957 showed an increase of 54% over the 1949 figure. Top place in exports of inorganic chemicals is taken by sodium products. Exports of calcined soda amounted in 1957 to 46,000 tons, as against 29,600 tons in the preceding year. Equally go-ahead were the exports of caustic soda which in 1957 amounted to 20,100 tons, as compared with 17,300 in 1956.

The same year also saw increased exports of a number of such inorganic chemicals as sodium bichromate, antichlore, ammonium acid carbonate, aluminium sulphate, etc. Increased demand by home industry produced a drop in carbide exports: 7,500 tons as compared with 23,900 tons in 1956.

There has been a distinct change, too, in the geographical structure of Polish chemical exports, and whereas European markets were the main outlet previously, such areas as North and South America, Africa, Australia and a number of Asian countries now receive a much bigger proportion. Some 33% of Poland's total chemical exports, in terms of value, went to these markets in 1957, as against 9.7% in 1949.

Analogue Computers

in Chemical Engineering



Analogue computers are a valuable new design tool for the chemical engineer, being able to solve rapidly and efficiently problems which normally involve weeks or months of plodding mathematical work. CHEMICAL & PROCESS ENGINEERING will present four separate articles, written by various authorities, summarising the usefulness of analogue computers in the design of chemical processes. In this first article, Mr. Thomas explains the basic principles and discusses the essentials of an analogue computer assembly.

I—General Principles

By G. E. Thomas, M.Sc.

(Chief Designer, Control Systems, Fairey Aviation Co. Ltd.)

AN analogue computer is a device that is set up as an analogue of the problem to be solved and simulates the behaviour of the system represented by the problem in all its states (*i.e.* it simulates the given system both in its dynamic and in its steady states). Computers of this analogous nature have been in existence for some appreciable time; indeed, a design was first formulated by Lord Kelvin as early as 1876, and two of the first machines were made at the Massachusetts Institute of Technology in 1931 and at Manchester in 1935. The machines have been known by at least three names—differential analysers, simulators and analogue computers, the name being chosen usually according to the purpose for which the machine was designed. The name differential analyser is applied to the type of machine designed to solve differential equations; the name simulator is often used to describe a machine designed to solve some specific physical problem. The tendency nowadays is to design multi-purpose machines which are known as analogue computers.

Most present-day analogue computers, therefore, are capable of operation as both differential analysers and simulators. As a differential analyser an analogue computer can readily solve: linear, constant coefficient, differential equations; linear, variable coefficient, differential equations; and non-linear differential equations. The dependent variable is represented by voltages (usually d.c.) or by the position of servo function units, and the independent variable is represented by machine time (which may be different to real time). Further, in the case of non-linear differential equations the independent variable may also have to be represented in the computer by a voltage.

These machines consist of assemblies of electronic and electrical circuits which may be connected and set up in such a manner that the behaviour of the computer as a whole is analogous to that of the system being investigated.

For example, the analogue computer and a physical system such as a mass suspended by a spring with the whole assembly immersed in some fluid can be made to obey the same equations. The analogue computer will represent the forces, accelerations and displacements by voltages (or currents) and a record of the voltage variations with time is a solution. The solution may be presented in ' real time ' or in ' machine time,' *i.e.* the analogue computer can be set up so that the time scale of the solution is faster or slower than that of the physical problem. This facility is of great importance when investigating plant performance involving large time lags.

The most important component, one might say the heart of the computer, is the operational amplifier which is used to perform algebraic addition, integration and many other functions. Basically, the operational amplifier may be regarded as a ' box ' of gain $-\mu$ (μ being very large) which takes negligible current from the input voltage and is capable of supplying a comparatively large current to the output load (see Fig. 1). The negative sign associated with μ indicates that for $+1$ volt input the output will be $-\mu$ volts.

A high-gain d.c. amplifier is used to

achieve these characteristics and, since the gain is very high, such an amplifier may produce output changes even when the input is a constant. For this reason a subsidiary a.c. amplifier and chopper relay is used to correct the ' drift ' of the d.c. amplifier.

This combination of d.c. and a.c. amplifier, together with the chopper relay, forms the operational amplifier.

The basic operations performed by multi-purpose analogue computers are: multiplication by a constant, algebraic addition, integration, differentiation, multiplication, division, and function generation. Let us consider each of these basic operations and see how they are performed in the computer.

(i) Multiplication by a constant

In d.c. analogue computers the usual method of achieving multiplication by a constant is by means of a potentiometer, which gives the constant K a range of $0 \leqq K \leqq 1$.

Fig. 2 shows the arrangement of a simple potentiometer and its usual symbol.

(ii) Algebraic addition

If input resistors $R_1 R_2 \ldots\ldots R_n$ and a feedback resistor R_f are connected to the high-gain amplifier as shown in Fig. 3, then by the use of Ohm's law and Kirchoff's laws it can be shown that:

$$E_o = -\left(\frac{R_f}{R_1}E_1 + \frac{R_f}{R_2}E_2 + \ldots\ldots + \frac{R_f}{R_n}E_n\right)$$

if μ is assumed to be infinite, and the grid current is assumed to be zero. More generally

$$E_o = -\sum_{i=1}^{n}\frac{R_f}{R_i}E_i$$

Actually, provided $|\mu| \geqq 100{,}000$ and $\frac{R_f}{R_i} \leqq 10$, and $n \leqq 10$, the error in assuming μ to be infinite is $<0.1\%$. Thus the operational amplifier may be used to multiply each input voltage by a constant $\left(\frac{R_f}{R_i}\right)$ and to sum the individual products. By choosing the relative signs of the input voltages they may be added algebraically. The ratio $\frac{R_f}{R_i}$ is not generally used to provide the multiplying constant; in practice $\frac{R_f}{R_i}$ has a fixed value (usually $1 \leqq \frac{R_f}{R_i} \leqq 10$) and a variable multiplying constant $K(0 \leqq K \leqq 1)$ is provided by a potentiometer as described in the previous section. Thus the process of addition may be drawn symbolically as in Fig. 4.

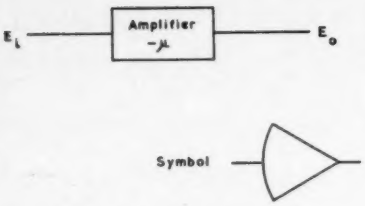


Fig. 1. Operational amplifier.

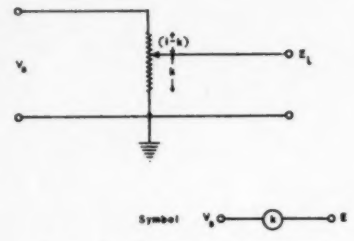


Fig. 2. Coefficient potentiometer.

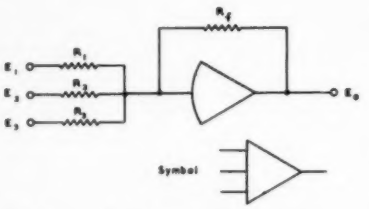


Fig. 3. Network and amplifier arranged for algebraic addition.

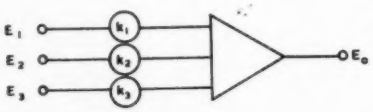


Fig. 4. Symbolic representation of adding (summing) unit.

The equation of the adding unit is given by:

$$-E_o = k_1\frac{R_f}{R_1}E_1 + k_2\frac{R_f}{R_2}E_2 + k_3\frac{R_f}{R_3}1E_3$$

(iii) Integration

If the high-gain amplifier has input resistors and a feedback capacitor as shown in Fig. 5, then the unit obeys the equation

$$-E_o = \frac{1}{R_1C_f}\int E_1dt + \frac{1}{R_2C_f}\int E_2dt + \frac{1}{R_3C_f}\int E_3dt + C$$

(with the same provisions for μ as in the summing case). The constant C is an initial condition introduced into the unit. Again the usual practice is to make the multiplying constant adjustable by potentiometers, thus resulting in a unit whose symbolic representation is shown in Fig. 6.

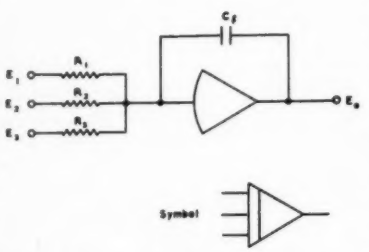


Fig. 5. Network and amplifier arranged for integration.

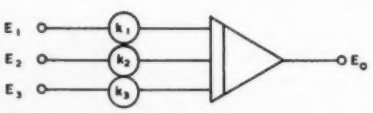


Fig. 6. Symbolic representation of integrator unit.

The equation of the integrating unit is given by

$$E_o = \frac{K_1}{T_1}\int E_1dt + \frac{K_2}{T_2}\int E_2dt + \frac{K_3}{T_3}\int E_3dt$$

where $T_1 = R_1C_f$
$T_2 = R_2C_f$
$T_3 = R_3C_f$

Often the resistors R_1 R_2, etc., are all equal, having a value R say, thus giving a value of $T = RC_f$ which is known as the time constant of the integrator.

(iv) Differentiation

A combination of components and operational amplifiers capable of approximate differentiation with respect to time may be obtained by interchanging the positions of the resistors and capacitors used in the integrator described in the preceding section. The resulting unit is as shown in Fig. 7. Computer designers and users avoid the use of differentiators because they tend to amplify minor disturbances and pulses and may cause unwanted oscillations to appear in the machine solutions. However, it is generally possible to rearrange the equations to be solved (or the physical system to be simulated) in such a manner that integrators may be used.

(v) Multiplication

Under this heading, devices to perform the multiplication of variable quantities (as distinct from multiplication by a constant) are considered. Such devices are usually represented

symbolically as shown in Fig. 8. The ideal multiplier should be capable of accepting many inputs x_1, x_2, etc., of both signs, together with both signs of y to produce output voltages having the correct signs associated with the products ayx_1, ayx_2, etc. The constant a in the output is the scale factor of the multiplier, *e.g.* if $x_1 = +50$ v., $x_2 = x_3 = x_4 \ldots\ldots = 0$ and $y = +50$ v.; and if the output $ayx_1 = +50$ v., then the scale factor of the multiplier $a = \frac{1}{50}$.

It should be noted that the ideal multiplier herein described is said to be capable of 'four-quadrant' operation, since it can accept any sign of the variables.

The devices used to achieve multiplication are many, but in the author's experience the following two types of multipliers have proved very reliable. The first type, an electro-mechanical servo multiplier, consists of a position servo driving six potentiometers, one of which is used as a position feedback potentiometer and the other five as multiplying potentiometers. The multiplying potentiometers are linear centre-tapped potentiometers supplied with voltages $+x$ and $-x$, etc., and the resetting potentiometer is also linear centre-tapped and is supplied with constant positive and negative voltages as shown in Fig. 9.

The other type is based on the relation

$$xy = \tfrac{1}{4}[(x + y)^2 - (x - y)^2]$$

and for this reason is often known as the 'quarter-square' multiplier. Although this type of multiplier is capable of multiplying only two variables together, as used in the Fairey multi-purpose computer it has the advantage of being able to perform four other operations by switch selection. These are squaring (x^2), square rooting ($\sqrt{x}$), dividing (x/y) and taking the difference of two squares ($x^2 - y^2$).

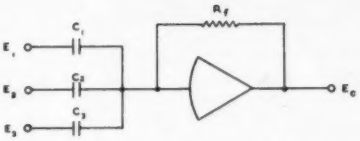


Fig. 7. Network and amplifier arranged for approximate differentiation.

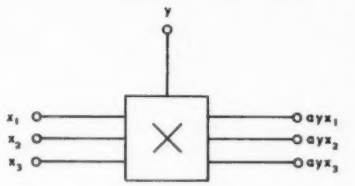


Fig. 8. Symbolic representation of a multiplier.

A third type of multiplier which is now being developed by Fairey Aviation is based on the time-division principle and is capable of multiplying the variable y by many variables x_1, x_2, etc.

(vi) Division

The ideal dividing element must accept dividend voltages x_1, x_2, x_3, etc., and the divisor voltage y to produce the quotients z_1, z_2, etc., as output voltages such that

$$z_1 = b\frac{x_1}{y} \qquad z_2 = b\frac{x_2}{y}$$

etc., where b is the divider unit scale factor.

The quotient z cannot be computed for all values of y since $|z|$ increases as $|y|$ decreases and hence all computers have a limit on the minimum value of $|y|$ which can be accepted.

The method by which an electro-mechanical servo multiplier may be set up as a divider is shown in Fig. 10.

Another method whereby a multiplier may be used to divide is by the solution of the equation

$$yz - x = 0$$

This method is shown in Fig. 11.

(vii) Function generation

Many problems to be solved on analogue computers involve the generation of voltages which are functions of time or functions of some other voltage. Computing elements used for this purpose (excluding functions which may be generated implicitly by the solution of simple differential equations) are known as function generators.

Often the non-linear properties of elements such as rectifiers, vacuum tubes and temperature-conscious resistors are used for function generation. The most flexible and reliable device in this category is based on the use of the diode as a switching device; units based on this principle are known as diode function generators. This type of unit cannot reproduce a curve but approximates to the required curve by a number of straight lines as shown in Fig. 12. The greater the number of straight lines available in the unit the more accurate is the curve reproduction. A device having, say, 10 straight lines available is known as a 10-segment diode function generator.

Another method for function generation is to use tapped potentiometers (or non-linearly wound potentiometers) as the five multiplying potentiometers on an electro-mechanical servo multiplier, thus achieving the multiplication of the input voltage to the potentiometer by a function of the shaft displacement.

Yet another way of producing $y = f(x)$ is by using a cathode-ray tube whose face is covered by a mask cut to the shape of $y = f(x)$. A photo-electric cell detects the position of the electron beam and provides a signal which is fed back to the C.R.T. in such a manner as to move the electron beam until it is partially shielded by the edge of the mask. A variation of the voltage x moves the beam across the tube whilst the photo-electric cell ensures that the beam is only just visible above the edge of the mask. Thus the beam follows the edge of the mask and reproduces the function $y = f(x)$.

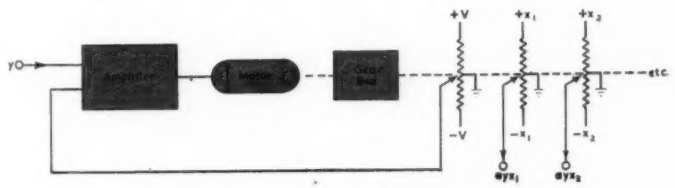


Fig. 9. Electro-mechanical servo multiplier.

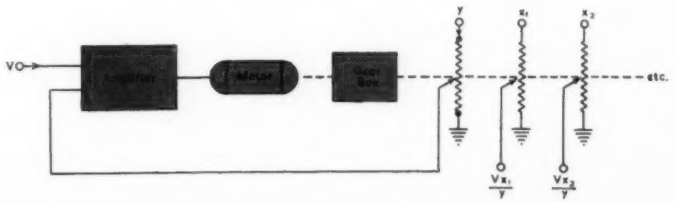


Fig. 10. Electro-mechanical servo divider.

Special units

Besides the ability to perform the basic operations already described, most multi-purpose computers have

facilities for performing special operations. The computer manufactured by the Fairey Aviation Co. Ltd. includes special operations such as dead space simulation, limiting simulation, transport lag simulation, the conversion of rectangular co-ordinates to polar co-ordinates and *vice versa*. Also special units are provided to allow the user to connect input and feedback networks around an operational amplifier in order to simulate a transfer function. This results in a saving of operational amplifiers.

Auxiliary units

Certain units which may be classified as auxiliary units must also form part of any computer installation. Typical examples of these units are: the computer power supply units; control units for switching the supplies and starting and stopping the machine solutions; units for checking the operational amplifiers and for indicating an overload condition of the computer; devices for introducing initial conditions, and the 'holding' of the machine solution at any chosen instant; recording equipment and meters for recording and displaying the machine solution; patch board connectors which enable an operator to pre-connect the problem wiring and later to store the patch-board for future use without waste of machine time.

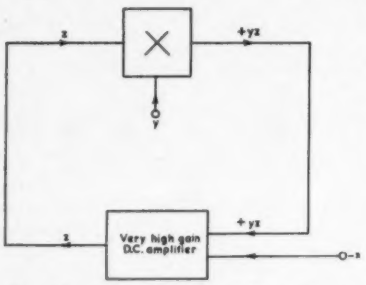


Fig. 11. Division by solution of yz – x = 0.

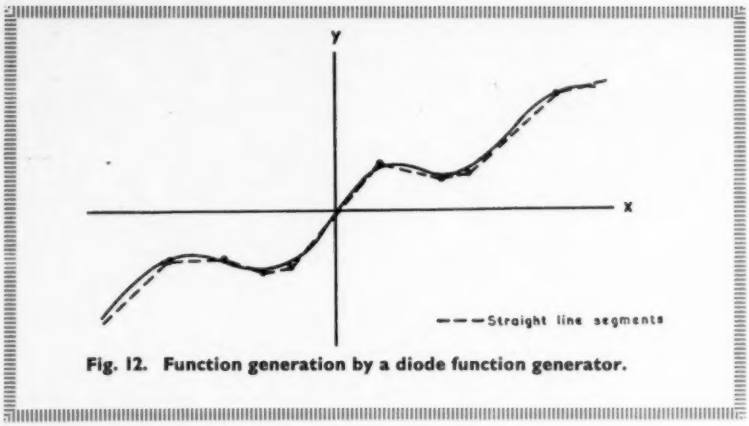


Fig. 12. Function generation by a diode function generator.

The computer assembly

The manner in which the various units are assembled to form a computer is not by any means standard and, naturally, various manufacturers have different ideas on this subject.

For this reason the form taken by computer assemblies will not be discussed. However, for the sake of completeness a typical analogue computer assembly is shown on page 343. The setting up and operation of an analogue computer in typical applications will be the subject of further articles.

Further articles in this series will deal with the applications of analogue computers to design work, with a practical example relating to a particular chemical process design problem, and with the economics of using such computers and their probable effects on design departments of the future.

Process Control by X-rays

Continuous chemical control of a process by *x*-rays is now possible and instruments are available which will perform analyses on materials that cannot be readily measured by other types of analytical equipment. Because of this, *x*-ray instrumentation is expected to supplement rather than make obsolete such process equipment as mass spectrometers, and infra-red and ultra-violet analysers.

The *x*-ray fluorescence analysis technique works best in analysing the basic products of the metals industries and in detecting small concentrations of metals in products of the powder or fluid process industries.

X-ray absorption predominates in physical measurements such as density, thickness, and level, but is gaining stature as an analytical method. To be considered a truly analytical tool, an instrument should selectively measure one or more individual constituents of a substance in the presence of varying amounts of the remaining constituents. *X*-ray diffraction meets this qualification by distinguishing and measuring substances on the basis of crystalline structure, and *x*-ray fluorescence by sensing atomic composition. Both phenomena follow the same fundamental laws, the difference between the two techniques resulting from the way these laws are applied.

Operation of fluorescent analyser

In a typical *x*-ray fluorescence analyser a sample is irradiated with *x*-rays whose energy exceeds the excitation potential of the desired elements in the product. The selected spectral energy is separated from the total energy by a diffraction crystal monochromator oriented in such a way that Bragg's law is satisfied for only the desired wavelength. Only the radiation characteristic of the element under analysis reaches the detector, and its intensity is linearly related to concentration when the sample is free of absorption effect. The techniques are more fully explained in *Control Engineering*, 1958, **5** (8), 94-99, by Mr. P. S. Goodwin, who states that the *x*-ray fluorescent analyser has a fairly wide range of applications, covering the 80% of the elements in the period table above atomic number 19. The measurements of tin and zinc plating weights have been completely developed, and efforts are now under way to tie in such readings to fully closed loop control. Other applications include the measurement of various elements in ore concentrates or tailings in smelting operations and the measurements of copper and bromide concentrations in solutions.

ION EXCHANGE

with particular reference to metallurgical processes

By D. A. Everest, Ph.D., F.R.I.C.

(*National Chemical Laboratory, Teddington, Middlesex*)

IN the previous article on ion exchange published in this journal[1] attention was directed to the inorganic technological applications of ion exchange, including metallurgical extraction processes, water treatment and the purification and recovery of various inorganic materials. The scientific literature covering the field of ion exchange is now extensively reviewed in a number of journals and it is considered, therefore, that a simple review of the subject would simply lead to further duplication. As a consequence, the scope of this contribution has been purposely narrowed to include only those applications which come under the heading of metallurgical extraction processes. It is considered that, in addition to its own intrinsic worth, this field illustrates most of the potentialities of ion exchange as a unit process. It must be emphasised, however, that, although the applications of ion exchange, both potential and in current use, to metallurgical extraction processes are very large, the most important industrial application still lies in the field of water treatment.

General principles governing the choice of a particular ion exchange system

In the majority of cases it is found that anion-exchange resins are of greater application in metallurgical extraction processes than are cation-exchange resins, at least if the latter are of the strongly acidic sulphonic acid variety (*i.e.* resins containing $-SO_3H$ groups substituted into the organic polymer matrix). This greater utility of anion-exchange resins results from their greater selectivity as compared with the sulphonic acid cation exchangers. This greater selectivity of anion exchangers can be ascribed to two main factors. Firstly, an anion-exchange resin can adsorb anionic metal complexes which are usually stable only under certain controllable conditions. For example, a sulphonic acid cation exchanger will adsorb both UO_2^{2+} and Mg^{2+} from a sulphate solution of a hexavalent uranium and magnesium. However, if an anion-exchange resin is used, uranium will be taken up by the resin as the $UO_2(SO_4)_3^{4-}$ anion; magnesium forms no such anionic sulphate complex and is not so adsorbed. Secondly, there appears to be an essential difference between the nature of the forces binding anions or cations to an ion-exchange resin. While the affinity of cations for a cation-exchange resin appears to vary inversely with the size of the hydrated cation,[2] the affinity of an anion for an anion-exchange resin appears to be dependent upon the polarisability of the ion concerned.[3] In the former case the adsorbed cations are bound to the resin sites by coulombic forces, whereas in anion-exchange systems polarisation forces between the resin sites and the adsorbed anion appear to be of chief importance. These latter forces are much more dependent upon the nature of the ion concerned than are coulombic forces, hence the greater selectivity shown by systems governed by polarisation forces. It is also characteristic of systems governed by polarisation forces that there is a much greater degree of interaction between the exchange sites and the adsorbed ions than in systems governed by coulombic forces. This in itself largely accounts for the greater selectivity shown by anion-exchange resins as compared with sulphonic acid exchangers.

The question of the selectivity of an ion-exchange resin is of great importance in any metallurgical extraction process. The use of an ion-exchange procedure is obviously only justified in those cases where more classical procedures fail, that is for solutions containing only small quantities of the desired metal in presence of excess quantities of impurities. Obviously the more selective a resin is with respect to the desired metal the greater will be the degree of purification achieved in the ion-exchange process. It must be emphasised that a high selectivity is not the only desirable feature of a resin—it must also possess a high capacity for the desired metal (not in every case does the most selective resin afford the highest capacity) and a reasonably rapid rate of reaction.

Uranium extraction

The application of ion-exchange resins to the extraction of uranium which was briefly reviewed previously[1] still ranks as the most important application of ion exchange in the metallurgical extraction field. The basic reaction involved in this process is the adsorption of the $UO_2(SO_4)_3^{4-}$ anion from a weakly acidic sulphate solution on to a strong-base anion-exchange resin. The uranium is then displaced (eluted) from the resin by passage of a relatively concentrated solution of nitrate or chloride; the uranium is finally recovered from the column eluate by precipitation with magnesia. Under the correct conditions concentrates containing 80 to 90% U_3O_8 can be obtained from very dilute uranium-bearing leach liquors containing large quantities of impurities. Considerable efforts have been made over a period of years to find the ideal resin and optimum operating conditions for this process. A summary of the various factors influencing the efficiency of the process has been given at the recent Geneva conference on the peaceful uses of atomic energy.[4]

A CPE Chemical Engineering Review

A number of modifications of this basic ion-exchange process have been proposed recently. In the Exer process[5] an attempt has been made to integrate the normal ion-exchange process with the production of uranium tetrafluoride, this latter compound constituting the normal feed for uranium metal production. The first stage of the Exer process consists of the adsorption of the $UO_2(SO_4)_3^{4-}$ complex on to a strong-base resin from a slightly acidic pregnant liquor in the usual way. An 8N hydrochloric acid solution is then passed through the loaded resin; this breaks down the uranium sulphate complex and sulphate anions are displaced from the column together with other anionic impurities, such as phosphate, which

are usually adsorbed along with the uranium. The uranium is retained in the column as it is converted into the strongly adsorbed $UO_2Cl_3^-$ complex. On passage of water through the column the latter complex is broken down into UO_2^{2+} and Cl^- ions which report in the eluate. Fluoride is added to the eluate and the solution reduced electrolytically when green salt (UF_4, 3/4 H_2O) is precipitated. Sulphate ions interfere with the reduction, hence the need for prior separation of the uranium and sulphate. About 90 to 95% of the uranium is precipitated at the reduction stage and the spent liquor is returned to the leaching circuit.

Ion exchange has also been proposed as a method for the concentration and separation of uranium from thorium present in monazite sand.[6] The latter is first broken down by treatment with hot caustic soda, soluble sodium phosphate is formed and thorium, uranium and rare earths precipitated as hydrous oxides. This mixed oxide residue is dissolved in mineral acids and the thorium and uranium precipitated at *p*H 5.5. The mixed uranium and thorium oxides are redissolved in carbonate solution, and the resulting solution passed through a column of *Amberlite* I.R.A. 400, when the uranium is adsorbed as the $UO_2(CO_3)_3^{4-}$ complex; the thorium together with any unseparated rare earths and phosphate passes into the column effluent. Carbonate, bicarbonate, nitrate and chloride ions are all found to decrease the column capacity for uranium, *i.e.* the equilibrium uranium loading on the column is found to increase on decreasing the concentration of the sodium carbonate. This is in marked contrast to the behaviour found for the adsorption of uranium from sulphate liquors when the column loading is largely independent of the sulphate concentration, although it is dependent on that of the bisulphate.[7] This probably indicates that, in the uranium-carbonate solutions, a considerable proportion of the uranium exists as the $UO_2(CO_3)_3^{4-}$ and that this ion is not formed primarily in the resin phase as appears to be the case with the $UO_2(SO_4)_3^{4-}$ complex.[7] The uranium is finally removed from the resin by means of 2N-sodium chloride solution followed by 2N-hydrochloric acid and a water wash in that order.

One of the difficulties encountered in the application of ion-exchange methods to metallurgical extraction problems is the occurrence of resin poisoning, that is build-up of impurities on the resin during plant operation which interferes with the loading or the elution cycle. This subject has been discussed at the recent Geneva conference with special reference to the uranium industry.[8] It has been shown that it is possible to roughly divide resin poisons into two main classes, non-permanent and permanent. The former can be considered to be simply ionic species with a high affinity for the resin; these species are adsorbed on the resin in preference to the desired metal and are only incompletely removed from the resin by the normal eluting procedure. Thus they slowly build up on the resin during plant operation. These species follow the normal laws of ion exchange and are not usually very difficult to remove from the resin. Polythionates and thiocyanate are typical examples of non-permanent poisons encountered in the uranium industry.

Permanent poisoning is exemplified by anionic cobalt cyanide species and by silica. In the former case small quantities of cobalt cyanide complexes occur in some uranium pregnant liquors; these species are adsorbed by the resin and then undergo slow reaction in the resin phase to form large polymeric species. Once formed, these polymeric species are very difficult to remove from the resin and they cause a serious and permanent decrease in the uranium capacity. Similar behaviour occurs with silica, although the polymeric silica species differ from the polymeric cobalt cyanide species in that they do not greatly affect the uranium capacity of the resin. The adsorbed silica, however, does reduce the possible flow rate of liquor through the column and it is found necessary to periodically remove it by treatment with caustic soda solution. With both cobalt cyanide and silica poisoning the adsorbed species do not appear to obey the normal laws of ion exchange and there is clearly much that is not yet known about the chemistry of these systems.

Resin-in-pulp procedures

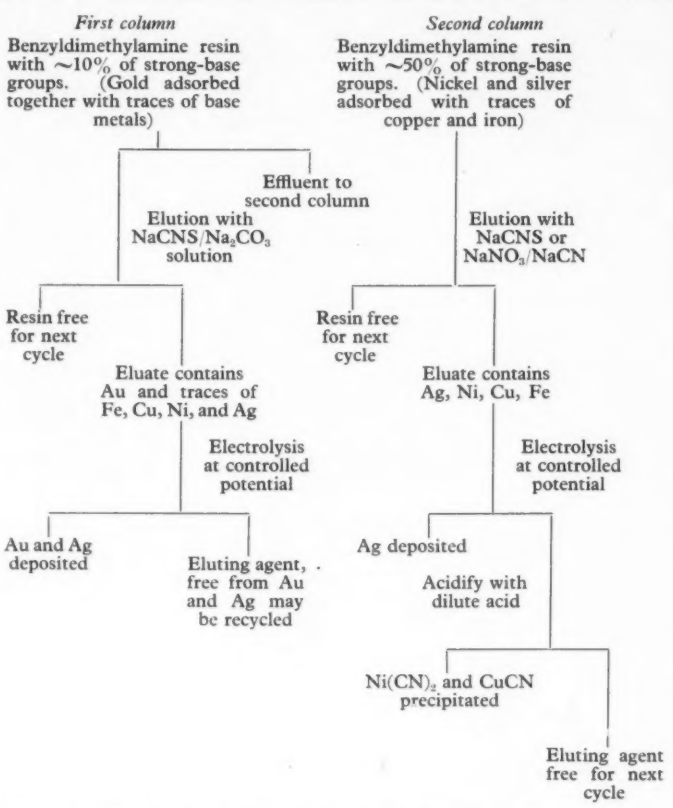
As was described in the previous article[1] considerable economic advantages are obtained by adapting ion-exchange operations to a resin-in-pulp procedure. Such pulp processes reduce or even eliminate the expensive filtration and clarification stages and, by avoiding the considerable dilution of the pregnant solution associated with conventional filtration or countercurrent decantation procedures, enable adsorption to take place from more concentrated solutions than usually occur in the conventional ion-exchange procedures.

One of the greatest advances in this field is the jigged-bed column developed in Australia by the C.S.I.R.O.[9] Use of such a column enables pulps of up to 30% solids to be contacted with the resin and also affords the operator all the advantages of a continuous process in contrast to the essentially batchwise operation of the conventional ion-exchange technique.

In this jigged-bed column leach pulp, from which the sands have been removed, is pumped upwards through a bed of resin (10 to 20 mesh) which is held against the underside of a 30-mesh screen across the top of the column. This screen is necessary, since stripped or partly eluted resin floats in the pulp. Blockage of the bed and screen is prevented by applying a slow gentle pulsation to the bed by a pneumatic system. A semi-fluidised bed is obtained which is non-turbulent, so that the multistage efficiency of a conventional ion-exchange bed is retained. The countercurrent pattern is preserved by gravity segregation in the bed; uranium-loaded resin, which is considerably denser than the unloaded resin, segregates at the bottom of the bed where it meets incoming pulp. The outgoing barren pulp contacts the lighter eluted resin at the top of the bed. Eluted resin is fed into the top of the column whilst loaded resin is withdrawn from the turbulent zone at the base of the bed in a stream of pulp. The resin is separated from the pulp on a 30-mesh vibrating screen and the pulp stream returned to the column. The loaded resin is then washed free of pulp and eluted in a separate column in which the eluant solution flows down through a bed of resin which gradually flows upwards. The overall process is thus continuous in operation.

Recovery of metals from cyanide solution

In the previous article[1] the recovery of gold and other metals from cyanide solution (in which they occur as anionic complex cyanides) on a strong base resin, *Amberlite* I.R.A. 400, was described. This work has now been extended and improved by the discovery[10] that weak-base resins are more selective than strong-base resins for aurocyanide in presence of base metal cyanides in alkaline cyanide solution. It was found, however, that, although a pure weak-base resin shows a high selectivity for gold under these


First column
Benzyldimethylamine resin with ~10% of strong-base groups. (Gold adsorbed together with traces of base metals)
Second column
Benzyldimethylamine resin with ~50% of strong-base groups. (Nickel and silver adsorbed with traces of copper and iron)
Effluent to second column
Elution with NaCNS/Na2CO3 solution
Elution with NaCNS or NaNO3/NaCN
Resin free for next cycle
Resin free for next cycle
Eluate contains Au and traces of Fe, Cu, Ni, and Ag
Eluate contains Ag, Ni, Cu, Fe
Electrolysis at controlled potential
Electrolysis at controlled potential
Au and Ag deposited
Eluting agent, free from Au and Ag may be recycled
Ag deposited
Acidify with dilute acid
Ni(CN)2 and CuCN precipitated
Eluting agent free for next cycle

Flow diagram for the recovery of gold, silver and nickel from an alkaline cyanide solution containing copper, iron and other anionic impurities.

conditions, the actual loading of gold per unit weight of resin was low. It was observed that the introduction of a controlled proportion of strong-base groups (*i.e.* 90% of the exchange sites were weak-base $-NHMe_2^+$ and 10% were strong-base $-NMe_3^+$ groups) gave a resin which took up a considerably greater quantity of gold at the expense of only a small loss in selectivity. Further increase in the proportion of strong-base groups in the resin caused a rapid decrease in the selectivity of the resin for gold, which in turn involved a decreased gold loading. In fact, for a particular solution a definite ratio of strong to weak-base groups (usually about 1 : 9 to 2 : 8) in the resin afforded the maximum gold loading. The theoretical reasons for this behaviour are somewhat complex and have been discussed elsewhere.[3] The gold on the resin could be eluted by means of aqueous sodium thiocyanate and the gold recovered from the eluate by electrolysis at a controlled potential.

It was also found[10] that resins containing about equal proportions of their exchange sites as strong- and weak-base groups showed a high selectivity and optimum resin loading for silver and nickel. These two metals could be readily recovered by elution with sodium thiocyanate or alkaline sodium nitrate, the silver being plated out from the eluate at a controlled potential and the nickel precipitated as simple nickel cyanide by addition of dilute acid.

A flow diagram for the recovery of gold, silver and nickel from an alkaline cyanide solution containing copper, iron and other anionic impurities is given in the accompanying figure. Such a liquor is encountered in the gold mining industry. A two-column system is used; in the first column is placed the correct resin for optimum gold adsorption. The second column contains the correct resin for optimum adsorption of silver and nickel. Pregnant solution is passed through the first column in which gold is removed and the first column effluent is passed to the second column for recovery of silver and nickel. The effluent from the second column contains iron, copper and other impurities and is sent to waste. As the processes occurring on each column are independent of each other, either column may be excluded from the system without influencing the behaviour of the other. This would be necessary if the concentration of the metals in the cyanide liquors fell below the minimum level for economic recovery.

Chemically modified celluloses

These materials were first investigated by Guthrie and co-workers[11] of the U.S. Department of Agriculture as part of a study of methods of flameproofing cotton textiles. It was subsequently shown at the National Chemical Laboratory[12] that a number of ion-exchange-type separations of cations could be achieved using phosphorylated cellulose as the chromatographic material. Further work has shown[13] that phosphorylated cellulose prepared under the correct conditions possesses a high affinity for certain cations; in particular for Th^{4+}, Ti^{4+} U^{4+}, Ce^{4+}, Fe^{3+}, ZrO_2^{2+} and UO_2^{2+}, which are all adsorbed from 4N acid. There are two main points of interest about the properties of phosphorylated cellulose as an ion-exchange material. Firstly, its selectivity is very much greater than that shown by sulphonic acid-type cation exchangers, resembling an anion-exchange resin in its high selectivity. With phosphorylated cellulose and the strongly adsorbed cations listed above, the evidence all points to the formation of directional partially-covalent-type bonds between the exchange sites and the adsorbed cation. This is similar to the behaviour of anion-exchange systems where a high degree of association is considered to occur between the exchange site and the adsorbed ion.[3] The second point of interest in the behaviour of phosphorylated cellulose is its rapid rate of reaction; this is caused by the hydrophilic nature of the cellulose matrix which is in contrast to the hydrophobic nature of the organic matrix of more conventional ion-exchange resins. One result of this high rate of reaction is that breakthrough curves with columns of phosphorylated cellulose are much sharper than with columns of conventional resins.

Phosphorylated cellulose has been applied as a selective adsorbent for the recovery of thorium from sul-

(*Concluded on page 352*)

Lead, one of the oldest corrosion-resistant materials known to chemical engineers, still plays a prominent part in plant construction. This article outlines its special features and applications in chemical plant, and discusses some of the special techniques that have been developed to meet industry's changing needs.

LEAD as a Material of Construction for Chemical Plant

By J. G. Openshaw
(*Director, William Openshaw Ltd.*)

ALTHOUGH lead has been known for its anti-corrosion properties since almost time immemorial, its use as a fabrication material in the construction of chemical plant is of comparatively recent origin. There are several reasons for this. In the first place the demand was lacking, since this only arose with the growth of the chemical industry itself. Again, the physical properties of lead (as opposed to its chemical inertness) were generally deemed to be antagonistic to permanent structures on a commercial scale. But most crucial of all, possibly, there was and still is no accepted technology of lead fabrication.

Even today, the fabrication of chemical plant in lead must be approached largely on a 'one-off' basis and the success or otherwise of an installation depends to an exceptional degree on the experience and know-how of the lead fabricator.

Special problems of fabrication

Although it may appear that the construction of chemical plant in lead is largely a matter of fabrication and erection, there are many good reasons why consultation with the fabricator should take place at the design stage. Thus, while fabrication is largely a matter of equating the process demands of the plant under construction to the construction demands, the kind of decision to be taken at the design stage includes such factors as the type of lead to be used, its suitability to the process conditions in operation (temperature, corrosive action, etc.), the amount of material required and the form in which it should be delivered from the lead merchant (to cut down waste, etc.), the question of fabrication on site or in the workshop and so forth.

The most obvious drawback to lead as a construction material is its tendency to creep. This can be specially irksome in installations where the unit is subject to fairly considerable variations in temperature—such as coil-type cooling plant. From the fabrication standpoint there are various methods of overcoming this hazard and the most appropriate must be selected, but the decision is largely one of design.

Erection is predominantly a question of location. It may take place either on site or in the workshop, and although the latter has many advantages, the size and nature of the plant often dictates otherwise. Some examples will make this clear. As is well known, the modern sulphuric-acid plant is far removed from the commercial installations of even a decade ago, which means that many of the lead fabrications have to be erected actually on the site. This calls for a measure of co-ordination between the work that can be done inside the factory and what must be achieved actually on the site that often cannot be predicted.

For example, during the erection of the mist precipitators and cooling towers for U.S.A.C. at Widnes there were no less than 400 tons of lead in the overall installation. This included

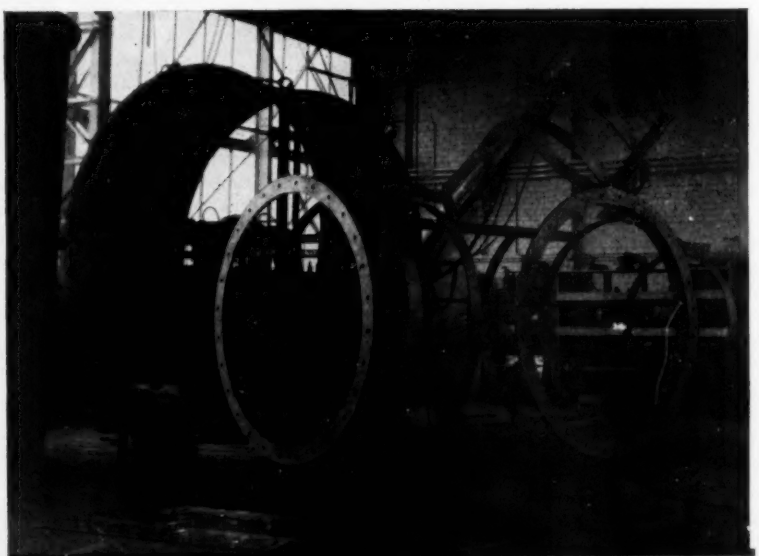


Fig. 1. Mist precipitator shell in course of lining, showing welded retaining pads.

five main sections to each precipitator, each section being lined in the workshop and subsequently erected on site. Each section measured approximately 12½ ft. in diameter by 5 to 6 ft. high and the sections had to be transported to the site from the works and then erected. With the cooling towers, which were 60 ft. high × 15 ft. diameter, it was necessary to erect the lead shell inside the supporting steelwork entirely on the site.

So much for the normal fabrication. On the other hand, homogeneous lining is practically always applied in the workshop, but even here in certain cases, *e.g.* saturators, the final stages in the lining process are finished on site.

Types of lead used

While much of the success achieved by lead in recent years in serving the changing demands in chemical-plant design and functioning may be attributed to its outstanding resistance to chemical attack and to the ease with which it may, in the hands of a skilled fabricator, be fashioned into the most complex designs, these two attributes, unfortunately, do not always act in conjunction. It can be that the type of lead most suitable to the process line is least suitable from the fabrication and construction standpoint, which usually means that some form of compromise must be found.

Happily, this is not unduly difficult. In the construction of chemical plant today, the fabricator has a choice of lead alloys from which it is possible in most cases to select a material of suitable characteristics for the particular application involved. The choice is mainly from lead sheet and pipe to B.S.S. type 'A', the type ' B ' alloys, antimonial lead and tellurium lead. The specifications for these leads are readily obtainable from the relevant B.S. publications and from the manufacturers. For instance, type 'A' chemical lead is of the highest purity and has a constitution of 99.998% pure lead. It is recommended for use where the highest degree of resistance to chemical attack is required. Against this it is prone when subjected to conditions of stress, such as vibration or repeated heating and cooling, to creep and intercrystalline cracking and hence requires careful design to ensure that it is adequately supported.

Type ' B ' chemical lead comprises lead of the same quality as type 'A' but to which has been added a small quantity of copper, silver, nickel or tellurium or combinations of these elements. One of the most useful of the type ' B ' leads is made by the addition of a maximum of 0.065% copper to type 'A' lead. The advantages gained are finer grain sizes and improved mechanical properties which naturally improve its fabrication potentialities. The disadvantage is a slight lowering of resistance to chemical attack, but in a majority of installations this still remains adequate.

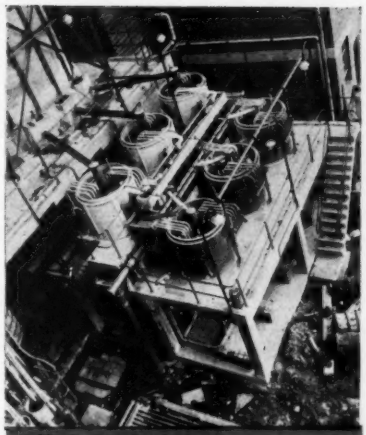


Fig. 2. Steel tube supports on lead pot cooler jackets at N.C.B. plant, Chesterfield.

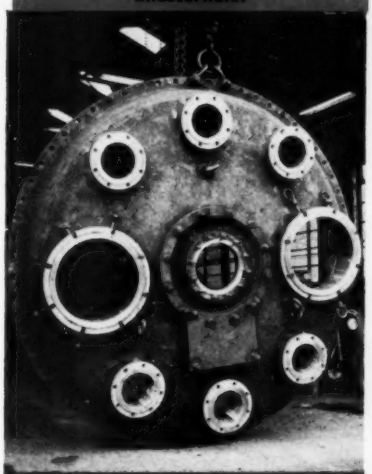


Fig. 3. Homogeneously lined 1-in.-thick mild-steel pressure vessel cover.

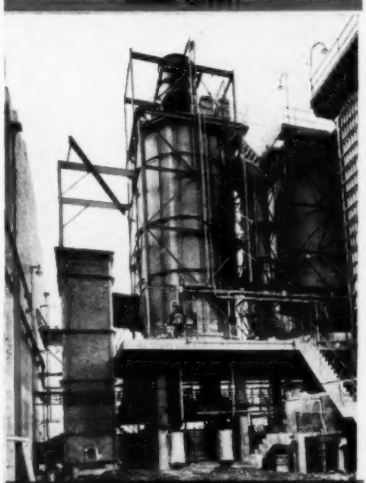


Fig. 4. Concentration tower at N.C.B., Chesterfield: ¾-in.-thick [illegible] sheets erected on site.

Antimonial lead is produced by the addition of amounts of antimony ranging from 0.5 to 8%. It produces sheet and pipe which is very stiff and consequently more difficult to work, especially in the higher percentages. Its uses range from linings for chromium-plating vats to designs which are required to be almost or completely self-supporting.

Incidentally, sheet lead is traditionally specified by its weight per square foot but it has become increasingly common to specify linings in actual thickness in inches or millimetres. It is available in a wide range of sheet sizes in any thickness normally required. Lead pipe is also available in a wide range of bores and wall thicknesses up to 12-in. bore, but as lead piping is more often specified to actual requirements rather than to the nearest available standard size, the fabricator is very much in the hands of the supplier. A good supplier, however, over a long period, accumulates a collection of dies and mandrils from which practically any size of piping can be drawn.

Typical fabrication in lead

The types of lead fabrication for chemical plant cover linings, towers (for scrubbing, cooling, concentration, etc.), ductings, fume stacks, coils, and so forth, each of which presents interesting constructional features.

Linings in lead, for example, fall into two classes, according to whether sheet lead or homogeneously bonded lead is required. In lining or covering all but the smallest pieces of equipment it is necessary to support sheet lead by means of straps fastened through the lining, which, in turn, must be covered with a strip of lead of the same quality and thickness as the main lining. This can be done in many ways but an interesting development latterly is the method adopted to retain the lining in mist precipitator shells (Fig. 1), or any type of lead lining for steel construction, *e.g.* a 6-ft.-bore exit fume stack for a large calciner gas-cleaning plant. For precipitators in particular the pads are welded to the mild-steel shell to avoid drilling and thereby facilitating the application of a suction balancing system.

Homogeneous lead lining

Homogeneous lead lining of vessels which are required to operate at high temperatures or under vacuum is a satisfactory answer to the problems of expansion and creep encountered under such conditions. There is little restriction as to the type of plant which can be protected in this way by a skilled operator and linings ranging in thickness from $\frac{1}{8}$ to $\frac{1}{2}$ in. or even more are commonly used.

Fig. 5. Lining of square section lead ducting, showing method of securing lining in mild-steel frame.

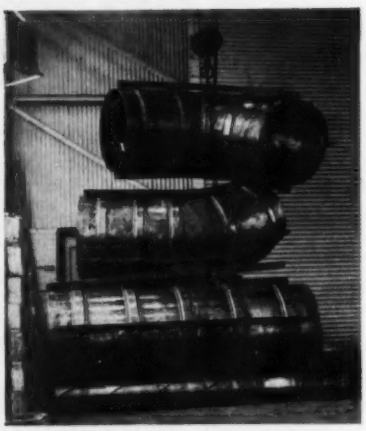


Fig. 6. Part of range of conventional circular lead ducting illustrating technique of large-diameter bend fabrication.

However, whilst there is no limitation as regards the process itself to the amount of homogeneous lining used, there is a cost factor which must be borne in mind.

Towers and coolers

The use of steel tube supports (Fig. 2), covered with lead straps, again, is often used in connection with acid-cooler water jackets. This type of cooler, each containing four cooling coils, was installed at the N.C.B. Avenue site, Chesterfield. The concentration tower in this installation, the lead sheath of which is $\frac{3}{8}$ in. thick, illustrates a method of suspending vertically the sides of towers for concentration, cooling, stripping, etc.

Whenever possible the shop prefabrication of chemical plant in lead has obvious advantages, but this is an example of the installation where it is necessary to fabricate on site.

Ducting

In many installations, such as gas-cleaning plant, it is necessary to fabricate the ducting from lead and this again introduces problems. For example, in a current contract the author's company is fabricating ducting in which the cross-section changes from circular to square and again to oval, with changes in diameter which span from 30 in. to 8 ft. Changes of this nature are, however, usually imposed by factory conditions rather than design requirements, but nevertheless they seem to illustrate one of lead's most useful properties as a construction material, namely its versatility.

Lead and atomic energy

As a shield for atomic radiations lead has been used extensively since the early days of *x*-rays, but since the development of nuclear engineering it has been occupied in more specialised uses such as cast-lead interlocking bricks, containers which may be in the form of lead pots or large steel cases filled with lead, shields, doors and wrappings. In all cases it is important that no blow holes should exist in castings which would reduce the effective thickness of the shield. To ensure freedom from such defects a method of non-destructive testing is employed to prove the solidity of the casting, or to locate faults and enable them to be rectified.

The peculiar fascination of lead as a construction material lies in its extreme adaptability. Even today it is holding its own as a general as well as a special-purpose construction material and chemical plant uses for lead seem likely to increase.

Ion Exchange

(*Concluded from page* 349)

phuric acid solutions of monazite rock and monazite sand.[14] It would appear that many other applications of this adsorbent are possible and that phosphorylated cellulose warrants further study.

It is of interest that carboxylic acid resins resemble phosphorylated cellulose in showing greater selectivity for cations than do the sulphonic-acid-type exchangers, especially as regards the transition element metals. This high selectivity of carboxylic acid resins is almost certainly due to weak complexing between the exchange sites and the adsorbed cations with formation of a partially covalent-type bond between the adsorbed ion and the resin site. Indeed, it appears to be a general rule that the selectivity of a resin for a particular ion can be increased by any factor which increases the degree of association between the exchange site and the adsorbed ion. It is those systems in which such a high degree of association takes place which are of the greatest application in metallurgical extraction processes.

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To Authors

The Editor welcomes practical articles and notes on chemical engineering and related subjects with a view to publication. A preliminary synopsis outlining the subject should be sent to The Editor, CHEMICAL & PROCESS ENGINEERING, Leonard Hill House, Eden Street, London, N.W.1.

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High-temperature Hot-water Heating for Industrial Processes

By Leo Walter, A.M.I.Mech.E.

This article discusses a system of heating by hot water which has advantages for certain processes. Various arrangements are described and some comparisons with steam heating are made.

THE history of high-temperature hot-water heating systems as applied to chemical processing and space heating goes back to the time when Perkins developed his well-known coil-heating system. In 1921 the first large industrial plant was installed in Germany, based on a design developed by an engineer of the chemical concern I. G. Farben. Plants followed in Switzerland (Sulzer) and in other Continental countries. In 1927 the idea of using the steam space of a boiler as an expansion space was explored. Natural circulation boilers have been adapted to this system. About 1931 the cascade heating technique followed in U.S.A. The forced-circulation boiler was introduced in 1936 and since then many plants have been installed, using La Mont boilers and others. In Europe, pressurisation by means of compressed air or nitrogen has been introduced during the last decade or so. Some plants of this kind are in operation, but for economical reasons steam pressurisation seems preferable. The main argument is that only steam keeps the system pressure continuously steady, irrespective of the size of the expansion and pressurisation space.

In recent years several specialised firms in the U.S.A. (American Hydrotherm Corporation and others) have built substantial heating plants using 200 to 400 p.s.i. pressure as compared with about 150 to 200 p.s.i. used in European countries.

Advantages of H.T.H.W. heating

Designers and contractors of high-temperature hot-water heating systems claim important investment savings. The fact that a steam-heating system has a large-bore steam flow piping section, a condensate flow piping section, and a drip-pipe system, as compared with a H.T.H.W. system employing a flow and return pipe of equal moderate diameters, is the basis for economy in first installation cost. Fuel savings up to 25%, owing to the elimination of all condensate and other losses inherent in a steam system, are claimed. Higher boiler efficiency can be expected. On the debit side comes the need for pumps, and often of heat exchangers. The maintenance and repair bill for these is, however, more than outweighed by the absence of steam traps, strainers, steam pressure reducing valves and condensate return equipment. The use of a closed circuit also obviates feedwater treatment. Reduction in boiler capacity is achieved owing to the accumulation of heat through the H.T.H.W. system, which takes care of peak loads. Uniform rate of boiler firing, elimination of blow-down, and clean boilers are additional assets. Tests have disclosed a much more uniform temperature distribution on press platens, etc. Improved accuracy of automatic temperature control is also achieved.

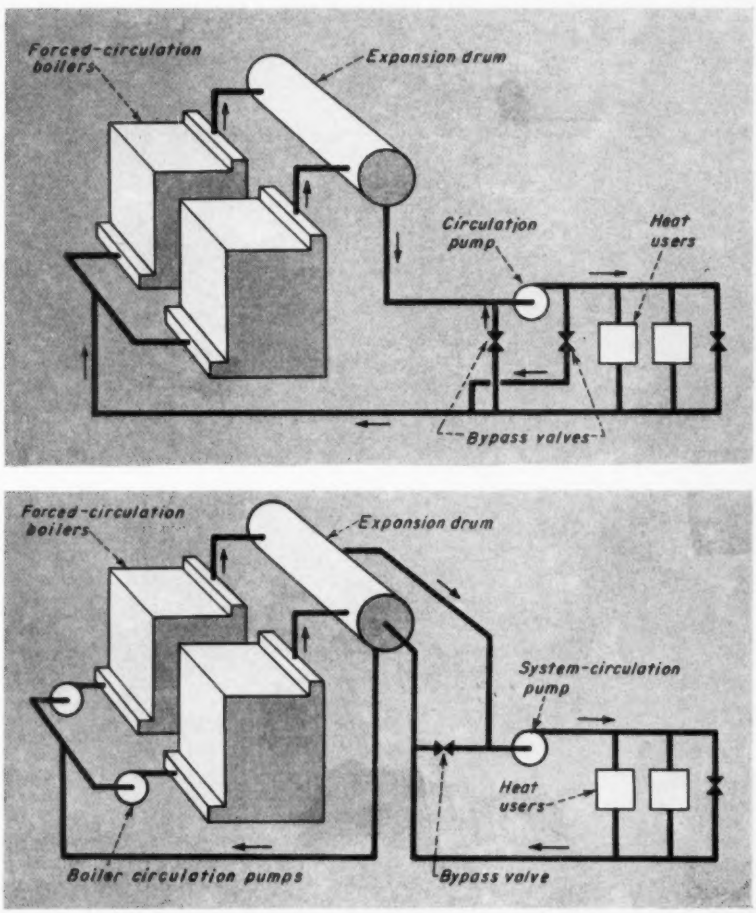


Fig. 1 (a) *(above)* **shows a one-pump circulation system for high-temperature hot-water heating, while** *(below)* **Fig. 1 (b) shows a system having separate pumps for circulating through boilers and distribution.**

Basically, however, a hot-water system has bigger process time lags, which in some instances may have unfavourable influence on the closeness of thermostatic control of large heating systems. Nevertheless, the keynote of any well-designed H.T.H.W. system is simplicity.

Fig. 1 (*a*) illustrates a one-pump-set circulation system, which is a low-cost system but lacks flexibility. Separate pump systems are preferable. They permit shutting down boilers or distribution systems temporarily without interrupting service. Fig. 1 (*b*) shows a multi-pump *Hydrotherm* system.

Main designs

(*a*) Hot water is produced directly, preferably in a forced-circulation boiler type.

(*b*) In a cascaded system the hot water is produced at high temperature in a direct-contact water heater by means of steam. Water temperature is raised in temperature to about 2°F. of the entering steam temperature. Cascade systems are often used by industrial plants having surplus steam available. The most economical uses are in instances where exhaust steam is available that would otherwise be lost (Fig. 2).

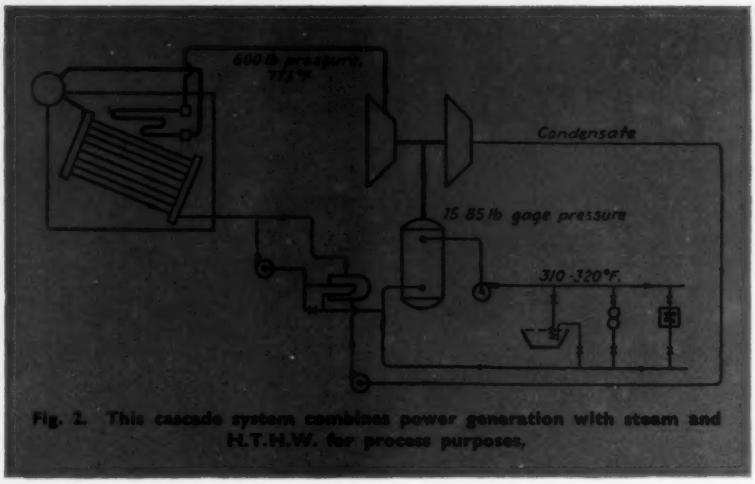


Fig. 2. This cascade system combines power generation with steam and H.T.H.W. for process purposes.

Heat-recovery H.T.H.W. systems

Calculations show that a steam process cycle can at best produce only one-fifth of the power of a H.T.H.W. process cycle. In many instances the latter system will be economical where steam-heated regenerative heaters had to be rejected. Back pressure from steam turbines has often to be determined following the choice of steam admission pressure. The balancing of power output with heat requirements is sometimes very difficult. Under certain working conditions the use of H.T.H.W. for process heating allows greater scope.

It may be less appreciated by potential users of process heating that a combined gas turbine/H.T.H.W. heat-exchanger cycle can be very efficient. With exhaust heat recovery the modern industrial gas turbine can operate up to 85% overall plant efficiency. A simple-cycle gas turbine can supply up to 140 kw. power/million B.Th.U./hr. when exhaust steam boilers are used. The reason that production of H.T.H.W. in special heat exchangers is more economical is that the exhaust-gas temperature can be reduced without exceeding an economical amount of heat-transfer surface. The size and cost price of a heat exchanger can be held reasonable, and more heat is gained for a given output of kw. in the plant. Fig. 3 shows a simple cycle of this kind.

The scheme includes by-passes *A* and *B* and an additional combustion chamber *C* is also provided for. When no process heat is required the by-pass valve *A* puts the regenerator of the turbine cycle into action. The unfired heater (exchanger) of the process heating circuit is by-passed by means of valve *B*.

When process heat is required the by-pass valve *B* is diverted towards flow to the heat exchanger (unfired heater). The surface may be dimensioned according to desired thermal efficiency (from 25 to 75%). Any periodic or continuous additional peak requirements for process heat can be satisfied from combustor *C*.

One example of the use of H.T.H.W. process heating is a platen press for forming plastic laminates. The advantages claimed for press-heating-cooling

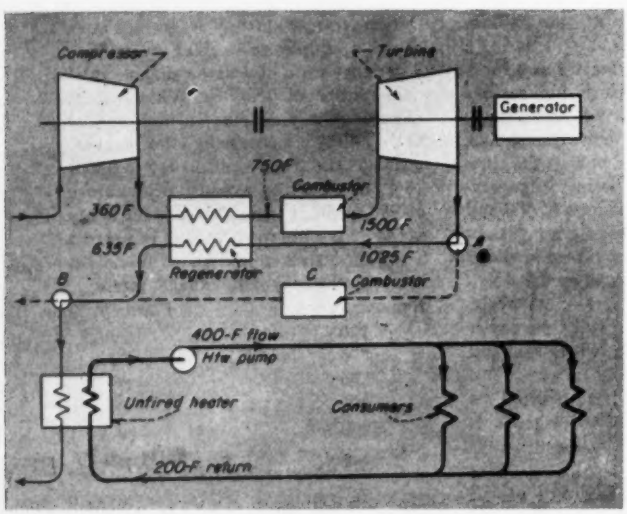
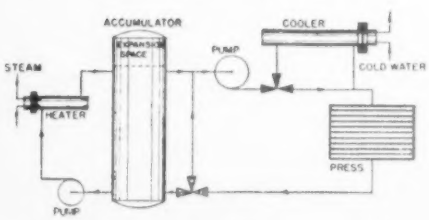


Fig. 3 (*left*). **Diagrammatic layout for industrial gas turbine and H.T.H.W. heaters for process heat and power generation.**

Fig. 4 (*below*). **H.T.H.W. heating of platen press using heating and cooling cycle. H.T.H.W. accumulator is applied.**



operation are (*a*) uniform surface temperatures; (*b*) close automatic temperature control for the heating and the cooling cycle; and (*c*) time-temperature curves can be well maintained.

Accumulators can be used with advantage to even out boiler load, when press operation is performed. Fig. 4 shows a typical installation for heating and cooling of a multiple-platen press.

A number of reasons can be put forward for converting platen presses from steam heating to H.T.H.W. heating. There is saving in fuel cost, while very efficient thermostatic control is obtained. Fig. 5 shows conversion of a platen press from direct steam heating of the platents to H.T.H.W. heating. By utilising a heater (converter) and accumulator for H.T.H.W., considerable reduction of steam consumption has been measured in actual tests.

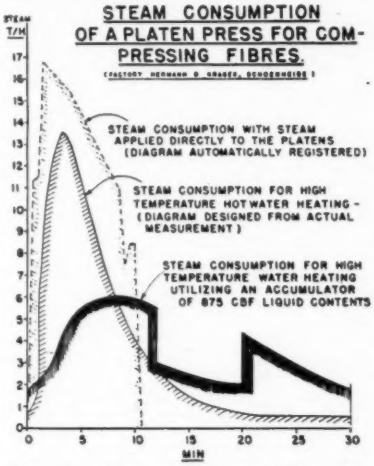

STEAM CONSUMPTION OF A PLATEN PRESS FOR COMPRESSING FIBRES.
STEAM T/H
STEAM CONSUMPTION WITH STEAM APPLIED DIRECTLY TO THE PLATENS (DIAGRAM AUTOMATICALLY REGISTERED)
STEAM CONSUMPTION FOR HIGH TEMPERATURE HOTWATER HEATING - (DIAGRAM DESIGNED FROM ACTUAL MEASUREMENT)
STEAM CONSUMPTION FOR HIGH TEMPERATURE WATER HEATING UTILIZING AN ACCUMULATOR OF 875 CBF LIQUID CONTENTS
0 5 10 15 20 25 30
MIN

Fig. 5. Steam consumption for H.T.H.W.-heated platen press: (a) using steam only; (b) using H.T.H.W.-heated platens; and (c) economy achieved by installing H.T.H.W. accumulator.

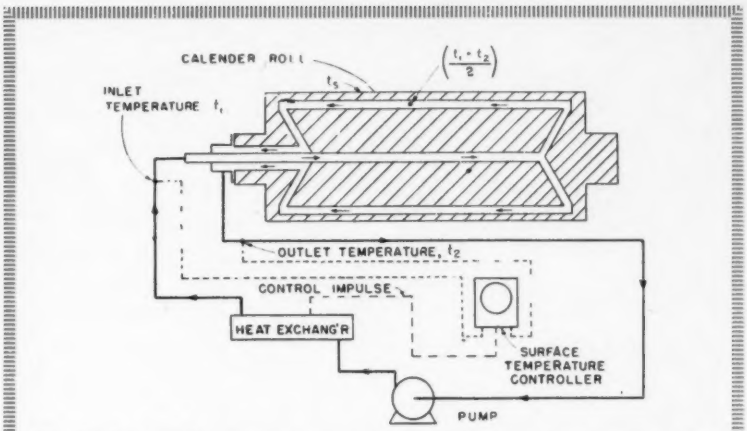


Fig. 6. Automatic temperature control scheme for calender roll heated by H.T.H.W. using heat exchanger.

The methods of thermostatic control of temperature for process heating vary, of course, according to working conditions. As an example, a control system for a calender roll is shown in Fig. 6. The H.T.H.W. flows through the roll as shown, the roll surface temperature to be controlled being t_s. If $t_1 > t_s$, cooling is required. For $t_1 < t_s$, heating of the roll is required. The temperature differential $(t_1 - t_2)$ may be utilised to produce control action, provided that flow quantity is practically constant. A simple computer-controller is used to keep t_s constant as desired, derived from changes of $(t_1 - t_2)$. In an instrument panel used for a calender in operation at the factory of the Goodyear Aircraft Corp., Ohio, four recording and six indicating controls produce the full picture for the plant operator. Pneumatic control is used, and some instruments allow switching from ' auto ' to ' manual ' control.

Acknowledgment

The author wishes to thank Mr. P. L. Geiringer, director and chief engineer of American Hydrotherm Corp., for providing data and illustrations.

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Nylon for steelworks sludge filters

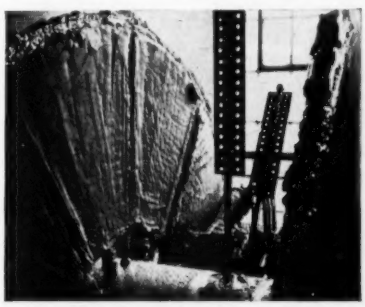
Cost savings have been achieved by the use of nylon filter cloths in a water-cleansing system at the Ebbw Vale iron and steel works of Richard Thomas & Baldwins Ltd., where the problem was not only to prevent river pollution but also to conserve water, used in vast quantities to clean gases from the blast furnaces.

Gases are cleaned in a three-stage dustcatcher/water tower/electrostatic precipitator system, the used water being fed to Dorr thickeners for clarification and return to the recirculation system.

It was the resulting sludge which presented the problem and filtration was found to be the answer, a plant consisting of three disc filters being installed.

After experiments with various filtering media, nylon was adopted. By using only four discs on a single filter it is possible to remove upwards of 2 tons/hr. of cake with a moisture content of about 30%, and on occasions the removal rate has reached 4 tons/hr.

Although the material is highly abrasive—consisting of more than 50% iron oxide—the nylon cloths have a life between two and three months. The fabric used is a 12-oz./sq.yd. continuous filament twill.



Filter unit, using nylon cloth to treat sludge from the settling ponds, at Ebbw Vale, South Wales, reducing it to an easily handled cake. The plant is claimed to be the only one of its kind in Britain in full working order. The paddle is for agitating the sludge.

New Trends in Fuel Efficiency

Constant progress is being made in devising new ways of saving fuel costs in industry and avoiding air pollution. At the 5th Industrial Fuel Efficiency Exhibition held in London from September 24 to October 3, over 170 exhibitors combined to demonstrate efficiency from fuel handling through boiler-house plant and instrumentation to the insulation of the factory itself. A selection of the exhibits is described below.

The main attraction at Davey, Paxman & Co.'s stand was their recently developed, high-velocity, treble-pass **boiler,** based on the *Ultranomic* boiler. To facilitate handling, the boiler, complete with burner and other ancillary equipment, is mounted on a fabricated under-bed equipped with lifting lugs.

This S-type boiler has a single flue set to the right-hand side from the burner end and two sets of tubes nesting on the opposite side, with smoke outlet at the rear. The front smoke box is integral with the boiler shell and has insulated lift-off doors. Large manholes give access to the boiler shell.

The fully automatic Associated British Combustion ' turbo-jet '-type burner is stated to give excellent combustion over a turn-down range of three to one under pressurestat control.

This class of boiler can readily be converted to burn solid fuels if the need should arise.

Davey, Paxman also exhibited a 10-sq.ft. **rotary vacuum filter,** one of a large range of filters used for extracting moisture from effluent slurries. With the present price of fuel, these filters are showing a considerable saving on kiln or other methods of drying by heat. The mechanical extraction of moisture has been installed by many manufacturers to reclaim deposits hitherto discharged to waste. This last has particular bearing on the discharge of noxious or harmful effluents into our internal waterways and rivers, or again in washing processes where water is at a premium; after the extraction of the deposits normally valuable in themselves the water can be returned to the system.

' Twice the speed and half the cost ' was the slogan of part of the Gas Council's stand where efficient and inefficient methods of **insulation, lagging and heating** were contrasted. Pictorial displays showed ' case histories ' of old and new ways of using heat economically. On the same stand was exhibited a new type of coke stoker for firing steam-raising boilers. It was manufactured by a British firm and tested by the Coke Technical Department of the Gas Council with good results.

The United Kingdom Atomic Energy Authority showed methods of reducing the cost of electricity from nuclear reactors by using improved **fuel elements.** The elements achieve longer burn-up and higher temperatures of operation, thereby increasing the reactors' efficiency.

A one-third-size model of *Zeta* and a 6-ft.-high model of the Dounreay materials testing reactor were also shown.

Controls for all stages in the production and distribution of heat were displayed by Honeywell Controls Ltd., including an indicating furnace pressure controller, a multiple-point electronic temperature recorder and pressure controllers. Space-heating control systems showed precision control of heat delivery with maximum economy. Low-voltage thermostats, electronic control panels, insertion and outdoor thermostats were some of the system components displayed.

Changing requirements in heating and boiler house practice resulted in the production of a new series of **controls** seen in operation on the stand of Radiovisor Parent Ltd. Fully automatic *Flamestat* units for operation on gas, oil or combination burners incorporate features which cater for every contingency and are flexible in sequence control adjustment.

The programme control section of this series is available separately to give automatic burner control using existing flame failure protection equipment.

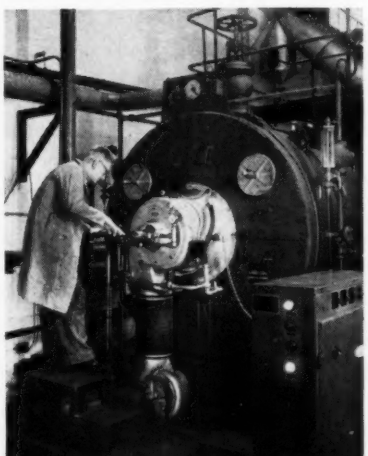
A new device, the *Motoload* relay, is of particular interest to engineers requiring a sensitive control or indication of load conditions on fuel and ash conveying and elevating systems. The unit has no moving parts, being operated from the current feed to the motor and offers trouble-free current control to very close tolerances.

A smoke - density - indicating and alarm control, and a simpler alarm equipment, were further features here, as well as photo-electric and electronic level controllers which have been applied to feedwater, ash disposal and fuel supply control systems.

Two exhibits on the National Industrial Fuel Efficiency Service stand illustrated improved **steam efficiency.** In one, the results of a test in progress during the exhibition were fed by landline into an Elliott's electronic computor on the stand, showing in a lighted tube the thermal efficiency of the boiler. These results were logged, demonstrating the improved performance obtained.

The other exhibit compared the fuel consumption of an efficient and an inefficient factory, listing the sources of loss in fuel consumption from the boilerhouse to the end of the manufacturing process. The illuminated plans showed a consumption of 95 tons of coal reduced, after improvements, to only 24.2 tons.

Panels showing the efficiency of nearly 700 boilers, using coals of varying sizes, indicated that combustion efficiency does not suffer, generally, when small coals are used, and that

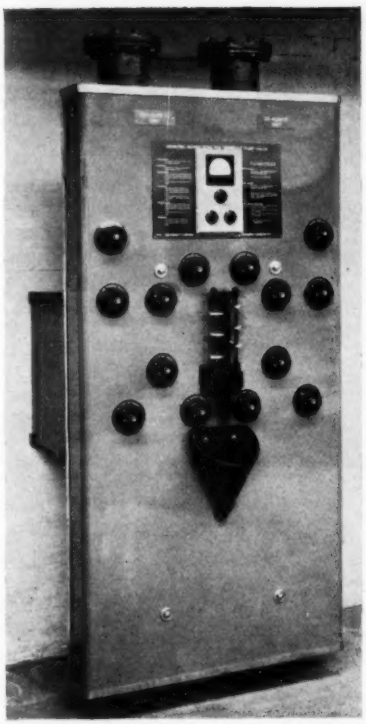


G.W.B. Furnaces ' Powermaster 200 ' packaged oil-fired boiler, supplying steam for process work and space heating at Sandoz Products Ltd.

the cost of using large coal or doubles is substantially higher than that of using singles or smalls.

On another panel, illuminated colour transparencies with brief case histories beside them showed how firms have implemented N.I.F.E.S. recommendations. A table shows that out of 347 recommendations made by N.I.F.E.S. over a period of six months 260 were very quickly implemented. Of these, 74 were concerned with operational improvements and needed no capital expenditure. The capital expenditure for the remaining recommendations amounted to £225,000. The savings amount to 30,000 tons p.a. of coal, or its thermal equivalent in other fuels. Thus the average expenditure to save one annual ton of fuel is only £7 7s.

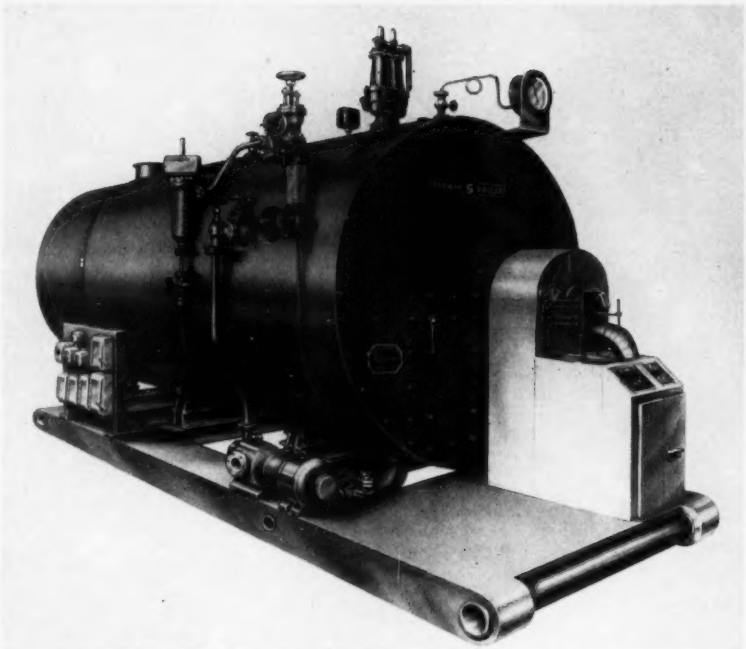
The chain-grate **stoker** shown by Bennis Combustion Ltd. is for use



Permutit Co.'s 'Deminrolit' ion-exchange water-demineralising plant.

with small water-tube boilers and furnaces. It is suitable for burning a wide range of solid fuels and is claimed to be completely smokeless in operation.

Also in operation was the *Low-Ram* stoker and a chain-and-bucket elevator which can handle 1½ tons/hr. of coal at a chain speed of 50 ft./min. Suitable for boiler, kiln and furnace applications is the *Minimeter* underfeed stoker which embodies the controlled-feed principle.



Davey, Paxman & Co.'s high-velocity, treble-pass S-type boiler mounted on a fabricated under-bed equipped with lifting lugs.

Dohm Ltd. exhibited a **fuel oil purifier** for adding to bulk storage tanks to convert otherwise unusable fuel oil into properly combustible fuel, while refractory glazes for the protection of all hot surfaces and sealing joints were also shown. Another exhibit was the CTF additive for coal-tar fuels, claimed to have special properties that inhibit sludge and eliminate all deposits already formed, resulting in better combustion.

An **insulation composition** for boiler and pipe lagging, with temperature limits up to 1,100° F., was a further feature of this stand.

The Drayton Regulator & Instrument Co. Ltd. demonstrated that the use of efficient **steam trapping** and correct control will save fuel. The demonstration consisted of a steam-coil-heated tank controlled at the boil by a self-operated *VT* controller, the coils being trapped by a Drayton/Armstrong steam trap. The increase of steam consumption resultant on poor trapping and lack of control was demonstrated.

Allied to this demonstration was a heat exchanger utilising the sensible heat of the condensate. Temperature recorders showed the condensate and tank temperatures.

The main exhibits by Elliott Bros. (London) Ltd. were two complete **boiler control** units in which standard Elliott and Bristol's instruments are used for indication, recording, and automatic control to maintain maximum efficiency for the load condition at any time. The instruments included cover the measurement of oil, steam and water flows, temperatures, levels and pressures; measurement and control of draught; flue-gas analysis and overall heat-meter (B.Th.U.) equipment. There was emphasis on electrical control systems as well as on the more conventional pneumatic methods.

James Gordon & Co. Ltd. showed a selection of components used in their versatile pneumatic system of automatic boiler control, including their type *S-D* modulating control for oil-fired boilers. Control valves, including butterfly valves of a specially tight-shutting design were also displayed. Sauter Controls Ltd. also showed a selection from their range of valves for various functions, including motorised valves and damper drives. The main exhibit by Panellit Ltd., another member of the Elliott-Automation Group, was a typical data-reduction and efficiency-computing system for use with an oil-fired steam-raising plant. The system is fed with signals representing fuel and feedwater input conditions, together with steam output, and automatically calculates at short intervals the overall boiler efficiency, printing out results in tabular form on a strip printer.

A full-size working installation of a typical oil-burning system embodying the various products manufactured by Zwicky Ltd. was shown by the company. Included were *Zwikleen* self-cleaning **filters** which are made in a range of sizes from ½ to 2 in. bore and three degrees of filtration, 0.003, 0.006 and 0.010 in. One complete turn of the handle removes the whole of the accumulated dirt which falls into the sump. The sump is easily removed for cleaning. The *N.Z.* dual filter is designed to ensure that the flow is uninterrupted when direction is changed for cleaning purposes and is manufactured in a range of sizes from ½ to 12 in. and in various materials to suit most liquids and working pressures. It is also made as a single type for use where plant may be shut down for cleaning.

Two **valves** displayed were the ½-in. pressure regulating valve which controls the pressure in the ring main and the ½-in. V-slot metering valve designed to measure the rate of flow to the burner. Other products included a 2½ × 2½ in. hand pump for use in boiler installations using *Dowtherm* and designed for topping-up the system against a pressure of 80 p.s.i. It has also been supplied for transferring ammonia and kindred liquids.

A scale model of a floating suction header was demonstrated. It is intended for use in bulk storage tanks and ensures that any water or sludge in the bottom of the tank is not removed with the oil.

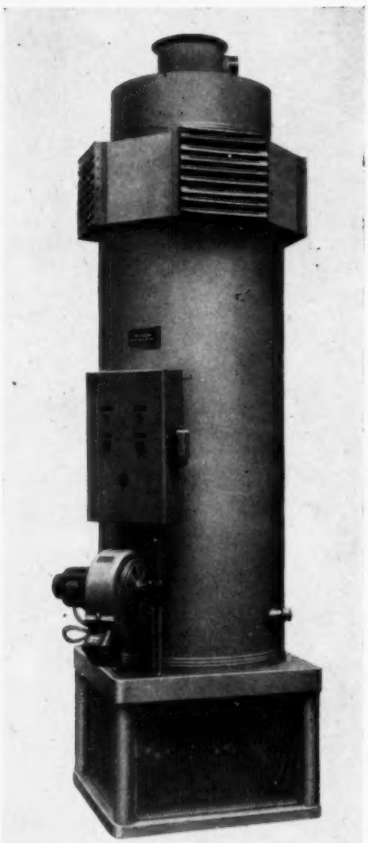
Teddington Industrial Equipment Ltd. featured a number of entirely new products, one of which was the *Transmatic*, claimed as the first British **air-conditioning control system** to make use of printed circuitry and a transistorised amplifier. Using sensing elements of particularly low thermal inertia and high stability, the system provides fine control of motorised valves, damper-motors or sequence switching units and can be set to match the characteristics and requirements of any individual installation. It is available for simple proportional control, for proportional control with either one or two stages of compensation, for averaging control (up to 10 points) and for the co-ordinated control of heating and cooling processes.

The new photo-electric version of the *Spediflam II* burner watcher has been introduced to cover the complete range of pressure-jet oil burners from the smallest domestic to the larger industrial installations. It uses the latest type of photo-resistive cell as a flame detector.

The new Teddington *WU* valve is designed for use with fuel oil at viscosities ranging from 200 to 1,000 sec. Redwood No. 1 at pressures between 0 and 300 p.s.i. It has a built-in adjustable by-pass and a mechanically-operated, three-contact switch which enables valve operation to be interlocked with the burner programme circuit.

The new **furnace pressure regulator** is of the proportional pattern and is used in conjunction with a proportional damper motor to control the flue draught or the pressure in the combustion chamber of shell-type boilers. The unit is operated by a large synthetic rubber diaphragm which is sensitive to minute changes in pressure.

G. W. B. Furnaces Ltd. exhibited two of their *Powermaster* automatic, oil-fired, **packaged boilers.** The *Powermaster* is either oil- or gas-fired,



The new John Thompson 'Beacon' air heater is oil-fired and is designed for small- and medium-size factories. Entirely self-contained, it is powered by a 2-h.p. motor and uses grades of fuel up to a viscosity of 40 sec. Redwood No. 1, giving an output of 595,000 B.Th.U./hr.

is automatic in operation and is smoke-free. Efficiencies of over 80% are guaranteed, and fluctuating loads are catered for with a negligible drop in boiler pressure. The fully modulating combustion control proportions the amount of fuel and air entering the burner at whatever rate the boiler is firing and the 5 : 1 turndown range, and the quantity of steam produced is automatically regulated in accordance with the demands made on the boiler. Fifteen standard models produce 500 to 20,700 lb./hr. of steam.

Sootblowing equipment for cleaning shell and water-tube boilers was exhibited by Ivor Power Specialty Co. Ltd. The Ivor traversing jet sootblower is used mainly for vertical, economic and smoke-tube boilers. It is operated by means of chain or extended hand-operating gear. Efficiency is gained by being able to clean the tubes whilst the boiler is on load. The Ivor industrial gun-type sootblower also on show is suitable for cleaning the walls or screen tubes of water-tube boilers.

Cochran & Co. Annan Ltd. exhibited a range of **boilers** including their *Sinuflo* economic boiler and three vertical boilers, one oil-fired by *Clyde* burner, one coal-fired by *Prior* stoker and one composite exhaust-gas and oil-fired for marine use. Also included was a *Ruths* steam-storage accumulator.

Representative types of **water-treatment plant** by Permutit Co. Ltd. were shown, including fully automatic, base-exchange, water-softening plant and *Deminrolit* ion-exchange water-demineralising plant. Also illustrated were other types of water-treatment plant for providing boiler feed and process water treatment and automatic control equipment.

New advances in both boiler plant and fuel-burning equipment for industrial service were displayed on the Babcock stand. Amongst the full-scale exhibits was the new *Renfrew* **stoker.** This is a 'packaged' stoker for the conversion of existing hand-fired water-tube boilers to mechanical stoking with the advantages of economical smokeless firing using low-grade fuels. It is also available as specified equipment on new boiler plant, with capacities up to about 25,000 lb./hr. of steam.

Also seen was the new corner-tube **hot-water boiler,** a compact forced-circulation boiler for modern high-pressure hot-water heating and pro-

cess systems. This exhibit is fitted with the Oldbury *Air-Spin* oil burner, an air-turbine-driven rotary-cup burner of simple design, in which combustion of the heaviest fuel oils is achieved at relatively low temperatures, with a consequent reduction in oil heating costs.

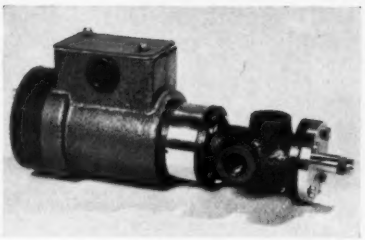
An animated display depicted the principle and operation of the Edwin Danks **thermal storage boiler,** which combines in a single unit the functions of steam generation and heat storage. A model of a Spencer-Bonecourt waste-heat boiler which gives economies in plant operation through utilisation of ' waste heat ' on the principle of turbulent gas-flow at high velocity was on show.

Another model was of the *Steambloc* packaged boiler showing the internal constructional features of this fully automatic, oil-fired unit for heavy-duty steam supply. Spencer-Bonecourt-Clarkson Ltd. also exhibited an oil-fired *Bato*/65 thimble-tube boiler, a compact, vertical-type boiler unit for rapid steam-raising and requiring a minimum of maintenance and attention

A display of *Fireye* flame failure safeguard equipment demonstrated its application to installations of both non-automatic and fully automatic burners. The equipment may be fitted to all forms of power or industrial boiler plants, water-tube or shell-type boilers.

Colour transparencies depicted the Castle Donington power station and also a modern *Bi-drum* boiler installation for a large steelworks, arranged for firing with blast-furnace gas, or for auxiliary or alternative oil-firing, and with provision for stoker firing with coke-breeze. Castle Donington power station, which is equipped with Babcock boiler plant, has achieved the highest overall thermal efficiency of all central generating stations in Great Britain.

Another new product at the exhibition was the *Inka* radiant-type **pre-heater,** now manufactured in this country by Newton Chambers by arrangement with Industrikemiska Aktiebolaget of Stockholm. Designed for air or gas preheating up to 850°C., it has considerably extended the upper temperature range of Newton Chambers' heat-exchange equipment. The method of heat transfer in the *Inka* is essentially and predominantly by radiation from the hot gases. It uses heating gases in the temperature range of 1,000 to 1,650°C. to produce high degrees of air and gas preheat. The mechanical design problems associated



New viscous-oil valve, shown by Teddington Industrial Equipment.

with units working at these high temperatures have been solved in the *Inka* unit.

The combination of an *Inka* and a *Newton* needle unit, also displayed, enables the highest thermal efficiencies to be obtained. The temperature of the waste gases leaving the *Inka* pre-heater is sufficiently high for use on the conventional *Newton* needle unit.

Introduced to this country by arrangement with the Struthers Wells Corp. of the U.S. and now made here by Newton Chambers are the Struthers Wells oil-fired heaters. These heaters are used for heating petroleum oils and organic fluids, cracking hydrocarbon liquids and gases, cracking chemical fluids and steam superheating.

Alfred Herbert Ltd. were showing their *Atritor* **drier-pulveriser,** which has been used for a number of years for the pulverised coal-firing of all types of boilers, rotary cement kilns, and various types of metallurgical furnaces. An advantage of this machine, of which some details were given in CHEMICAL & PROCESS ENGINEERING, 1958, **39** (6), 201, is the wide range of fuels that can be used while still maintaining high outputs and great flexibility. It is claimed that *Atritor* firing gives the advantages of oil firing, but with the economy achieved when using coal. The actual economy will depend on the price of the two fuels in any given district. In general about 1½ tons of coal are used to every ton of oil; comparative costs suggest a saving of 25 to 30% when using coal.

The *Atritor* dries, pulverises and delivers the coal to special burners. Raw coal is generally stored in a bunker above the machine, this bunker being fed by an elevator, conveyor or similar equipment. The primary air is a fixed quantity preset by the pulveriser manufacturer and requires no attention by the operating staff. The control of the quantity of coal is simple, being either by remote variable-speed control or, alternatively, if the machine is directly in front of the boiler, by a handwheel on the feeder. The make-up of the air supply is in two forms: (*a*) fan-distributed secondary air with suitable lever control for adjustment; and (*b*) induced tertiary air around ports in the burners themselves.

For moisture contents up to 14% the standard machine is used with a standard separator feed. For moisture contents from 14 to 18% the ascension-tube method of feed is used to pre-dry the coal before entry into the *Atritor* and to separate any tramp metal, foreign bodies, etc. For really high-moisture-content coals such as slurries special feeding equipment is used.

For example, a Lancashire boiler operating at a colliery gives outputs of 10,000 lb./hr. evaporation without an economiser. This installation in operation on slurry for some 10 to 12 months has achieved spasmodically a peak load of 12,000 lb./hr.

A number of new products and new developments of the John Thompson Group of companies were on show including a *Multipac* **package boiler** of an entirely new design, a feature being the built-in ' wet back ' combustion chamber, designed to provide adequate volume while also giving a very high degree of flexibility and eliminating the necessity for refractory linings. The required volume is obtained by using a dished-end design for the ' wet back ' combustion chamber; this also reduces the number of stay bolts, further support being given by the cleaning door and sootblower housings.

The boiler also has the advantages of having two passes of fire tubes arranged below the flue, with clear water space above as in a super economic boiler, and has independent tube plates. The *Multipac* is available complete with forced-draught fan, feed pump and a fully automatic, fully modulating rotary cup oil burner. The burner is capable of burning all types of fuel oil up to and including 3,500 sec. Redwood No. 1 without the addition of a pumping and heating set.

There are 11 sizes of *Multipac* units at present listed.

' Terylene ' for filtration. The various properties of *Terylene* which make it particularly suitable for many filtration operations, such as resistance to abrasion and flexing, high strength and dimensional stability, are described, and the effects of heat and acids upon it illustrated by tables in a booklet obtainable free from I.C.I. Ltd., Fibres Division, Hookstone Road, Harrogate, Yorkshire.

This article briefly summarises the requirements for the efficient storage, distribution and metering of liquids in industry, and discusses some of the latest ideas in automatic control.

Accurate Liquid Control

By H. G. Davis

(*Manager, Industrial Engineering Division, Wayne Tank & Pump Co. Ltd.*)

THERE is scarcely an industry which does not call for the use, in some process or other, of liquids—solvents, lubricants, coolants, diluents and so on. In the majority of cases the industrial application in bulk of a laboratory experiment is involved and extreme accuracy of measurement and control is therefore necessitated. In the past there was no option but to indulge in laborious methods of measuring out in containers and weighing, but, in order to keep pace with the requirements of modern industry, considerable technical advances have of necessity taken place. Nowadays methods exist that can ensure the efficient and accurate control of basic liquids upon which quality and the quantity of production can depend.

It will be generally appreciated that the whole business of fluid handling falls naturally into three phases, namely storage, conveyance and measurement. Each phase must be considered in the light of individual requirements.

Storage

For the purposes of this article we need deal only briefly with storage, as it is with distribution and measurement that we are mainly concerned.

Bulk supplies are usually stored in cylindrical underground tanks. This is not only the safest method of dealing with hazardous liquids but leaves vital ground or floor space available for other purposes and permits bulk purchases to be made with a resultant saving in cost. There are, of course, regulations governing the storage of numerous liquids both above and below ground, and the local authorities should, in all cases, be consulted about these. It should be borne in mind that adequate provision must be made for cleaning of storage tanks at regular intervals, and new tanks should have suitable means of entry for this purpose.

Distribution

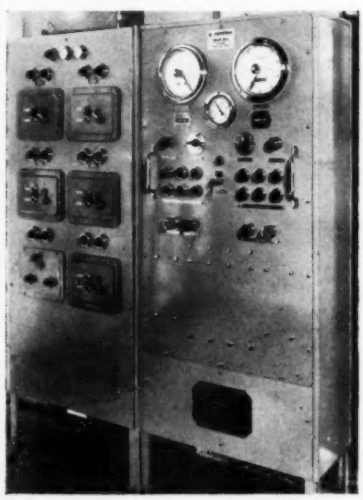
Various methods are available for distribution of the liquid from the main storage point and, while straightforward gravity feeding can sometimes be employed, this involves above-ground storage tanks and there is always the problem of maintaining sufficiently high liquid level in storage to provide the necessary head pressure in the system.

There is also the problem of variation in head pressure as the storage level drops. It is therefore in the long run probably better to adopt some system of pumping from below ground as being the most versatile. Most liquids can be adequately handled either by positive rotary or centrifugal-type pumps dependent upon installation conditions, but it should be borne in mind where underground storage is involved that adequate priming facilities must be provided for the pumps concerned. In this respect pumps are available which, as well as being self-priming from dry, will maintain adequate priming of the suction line even under the most adverse conditions. If, however, straight centrifugal pumps are to be employed, it is essential that they should be installed so that they operate at all times with fully flooded suction.

Careful consideration must always be given to the effect that the lubrication properties—or more often the lack of lubricating properties—of the liquids handled will have on the pump. Positive pumps of the gear type depending on liquid seal principles rather than reciprocating pumps with actual metal-to-metal contact are preferable. In this respect corrosive fluids must be given special consideration to ensure use of the proper type of pump. The market is adequately catered for in all these directions and it is sufficient to draw attention to the problems.

In all cases it is advisable to keep pumps as near as possible to storage tanks.

Many liquids, particularly in paint manufacture and confectionery, can



▲ A bank of meters in an industrial installation requiring the accurate measurement of batches of highly volatile solvents.

Central remote panel for complete liquid batch control. From the control point, any liquid can be selected and a predetermined quantity can be caused to flow automatically from storage tanks to mixing vessels. ▶

be extremely viscous. Here, raising the temperature and thus reducing viscosity can often be employed, the additional cost of effecting this being offset by the reduced capital outlay necessary in smaller pipelines and pumps and the lower running cost of smaller-horsepower prime movers.

All the foregoing considerations are purely mechanical and need present no great problems, provided adequate and proper equipment is employed.

Measurement

When we come to the question of measurement we are entering the realms of exact science, and here the modern positive displacement meter is now in extensive use.

Of the meter types available for handling liquids in bulk quantities, those which operate by volumetric displacement are the most accurate and efficient. Meters capable of handling over 400 gal./min. to an accuracy of 0.1% at pressures up to 125 p.s.i. are obtainable.

The modern meter of this type can be equipped with a range of accessories and devices which fit it adequately into present-day concepts of automatic control. First and foremost among these is the automatic set-stop. This device enables the operator to preset any required quantity of liquid which the meter will then deliver, automatically stopping upon completion. Almost complete elimination of human error is thus achieved. In addition, where large quantities are involved, the operator is released for other work during the delivery period.

Quite apart from accuracy of measurement, rate of flow has often to be controlled and proper records have to be kept. Rate of flow indicators can be fitted, either adjacent to or remote from such meters, while ticket printers provide a 'tamper-proof' method of recording on paper details of individual and total deliveries.

It should not be assumed that metering can only be applied to the large installation handling quantities in great bulk. There is plenty of scope for the application of metering for small quantities at local points. In such cases the preset is probably superfluous, but the meter performs the vital function of providing an accurate record of throughput.

Finally, compensation for temperature variation must be considered. Here again potential users are fully catered for, as meters both large and small are available fitted with automatic temperature compensation devices capable of operating over considerable ranges of temperature variation.

Mixing container with motor-control valves—part of the system controlled by central panel shown on opposite page.

Pumping arrangements

In essence, then, the modern liquid control system will consist of bulk storage tanks, conveniently sited for ease of replenishment from the material supplier. Where a variety of liquids require to be distributed it has been the practice in some installations to use a common pump for all, with cross-over valve arrangements provided to allow the appropriate tank to be put 'on stream.' There are considerable disadvantages with this method, not the least of which is the necessity for some cleansing fluid to be pumped through circuits between different deliveries, to obtain absolute purity. In all, therefore, the practice is to be deprecated, as any initial saving in capital cost will almost certainly be offset in the long run by increased operating costs. As a general rule, where a variety of liquids is to be handled, it is infinitely better to employ a separate pump for each.

The pumping installation will be sited as closely as possible to the storage tanks and, as the prime function of this is to create the necessary head pressure in the distribution system, the pumps, if they are positive, must be provided with some form of relief valve installed between the suction and delivery lines. As final control on the delivery of the liquid batches is a function of the meter at the delivery point rather than the pump itself, arrangements are often made whereby the pump motors are remotely operated from the delivery point, thus economising in time, labour, and excessive pump running costs.

Metering

From the pump house, pipe runs of suitable diameter—which will be governed by the viscosity of the

Typical Wayne Smith pump installation for handling solvents.

liquid, length of run, rate of flow and the pressure available—will be laid to the various supply points throughout the installation. At these, meters with preset mechanism will control and measure the batches of liquids required to the actual process container. These meters will only be accurate, of course, provided they are at all times passing fluid containing no air or vapour. Immediately before the meters, therefore, adequate air eliminators may be required dependent upon conditions.

The number of meters required will depend entirely on the demands of the process, but considerable elasticity of arrangement is possible by the use of cross-over pipes and selector valves.

Automation in liquid control

So far we have considered only systems which call for manual operation at various points. With automation to the fore, as it is today, we must now consider how liquid control systems can fit into this picture.

Meter and valve manufacturers are, in general, keeping abreast of the times, and there are models of both items which lend themselves to the design of systems which will enable complete control to be effected from a single centralised point.

The desired object here is for a single operator to be able to effect distribution of repeat batches or variable quantities of a variety of liquids from central storage to widely dispersed usage points. In order to achieve this, two basic requirements have to be met, namely simple yet safe push-button control and automatic feed-back to the controller of information confirming the accuracy of the batches delivered.

The general arrangement of systems such as this is similar to that already described. A large degree of control, however, is effected by remotely operated valves, either of solenoid or motorised type. No control is exercised by the pump, the object of which is to create constant pressure throughout the entire system. The pump must, therefore, be either of centrifugal pattern or, if positive, provided with adequate pressure relief, by-pass valve.

Preset meters must be employed, and these, by means of electrical impulses generated, feed back to slave dials on the central control panel.

On the control panel are incorporated selector switches which are coupled to the various valves. By means of these the required liquid can first be selected, and then the circuit through which it is to flow. The necessary quantity is preset on the slave dial and delivery is commenced by operation of a master push button. Impulses from the delivery meter transmitted back to the slave dial indicate on the latter the amount delivered throughout discharge. Immediately prior to completion, trips come into operation which close the delivery valve at the exact moment of completion. In large systems this closure must be progressive over the final stages of delivery to prevent the creation of pressure surges in the system.

It will be appreciated that the fundamentals of the system have been dealt with only in outline and in simple language and that, in the process of its design and construction, many problems can be involved. Many such systems are, however, in satisfactory operation today, and none of these problems is insoluble. The first steps in fully automatic control have now been taken and attention is being turned to the application of electronics to the master control system. It is no far cry from the time when prerecorded tape or punch card systems will be in general use as master controllers of such systems as have been described here. With their introduction greater and more consistent accuracy can be achieved and elements of human error will be eliminated.

INDUSTRY REPORTS

Precious metals for industry

News of new plant and expansion of existing plant was reported in the annual statement of Murex Ltd. chairman, Mr. A. J. G. Smout. The present pilot plant for the production of tantalum has been expanded and the new plant for the production of tantulum and niobium is scheduled to operate next year. Plans for increased production of fabricated tantalum products are also in hand.

The new molybdic oxide plant is now completed and in operation. Plans for the Rainham works during the coming year include modest expansion in the powder metals group.

The company's agreement with the Rhokana Corp. in Rhodesia for the refining of cobalt terminated during the year. The Murex plant has been fully amortised and the buildings adapted for new plant. The pilot plant designed to produce sponge metal by a small batch process from zirconium tetrachloride—mainly for the U.K.A.E.A.—will probably cease production when the U.K.A.E.A. contract ends in the autumn of this year.

Commercial usage is likely to be slow and uncertain in developing and production costs are high in comparison with those of the U.S.A.

Heavy and petroleum chemicals

A further diversion from the fermentation of molasses as a source of industrial alcohol and other chemicals to the production of these materials from petroleum has been a feature of the Distillers Co.'s recent activities, as a result of the high cost of molasses. The chairman, Sir Graham Hayman, stated in his annual review that four of the six large fermentation plants have now been closed.

Calcium carbide output from the company's plant in South Wales reached a record tonnage in production and sales. Chlorine production by Murgatroyd's Salt & Chemical Co. (in which Distillers have an equal interest with Fisons Ltd.) was in advance of designed capacities.

Further expansion is under consideration at British Hydrocarbon Chemicals, Grangemouth, where output from the second ethylene and ethyl alcohol plants has been up to expectation. Production of a new type of high-density polythene is hoped to commence early in 1959. Called *Rigidex*, its outstanding qualities are rigidity, resistance to high temperatures, and toughness. During the year the company commenced the construction of a plant at Grangemouth to produce phenol.

Another new plant for the manufacture of oil-resistant synthetic rubber and latices has been brought into operation and the products are being marketed under the trade mark *Hycar*.

Cement production

Due mainly to the bank rate and the credit squeeze and its effect on the building industry, the Tunnel Portland Cement Co. and its subsidiary companies had to report a decrease in production. One exception was the Clyde Portland Cement Co., where capacity has recently been increased by the installation of a new grinding mill. Additions to the assets of the group include a new kiln and mill at the West Thurrock works and a white cement plant at the Pitstone works.

At West Thurrock works, which is the largest cement works in the country, continuous attention to fuel efficiency has enabled the increase in the cost of coal per ton of cement to be kept down to 402% over 1938.

Large-scale Water Treatment

ECONOMICAL OIL REFINERY/POWER STATION ARRANGEMENT IN U.S.A.

By John Grindrod

How the two industrial processes of oil refining and electricity generation can be combined to mutual advantage has been demonstrated in New Jersey, U.S.A., where one of America's largest and most modern water-treatment plants has been constructed. Details of the plant are given below.

THE new $100 million Linden power generating station of Public Service Electric & Gas. Co., of Newark, N.J., has been constructed adjacent to the Bayway refinery of the Esso Standard Oil Co. At the oil refinery the processing of crude oil to refined products is aided by the use of the generating station's low-level heat energy and, at the power station, refinery residuals and refinery raw water are used for generating electricity.

In a conventional generating station the same water is used over and over again so that water treatment is not required on a large scale. At Linden, however, where 1,550,000 lb. of steam can be sent to the refinery every hour, an amount of water at least corresponding to this must be added to the system. Raw water for this purpose is received as part of the exchange arrangement from the refinery and is made 99.9998% pure in a plant which is divided into a primary treatment and a demineralising section, as follows.

Primary treatment of water

Designed to operate unattended by remote manual or automatic control, the primary treatment section receives raw water, which is fresh water drawn from nearby creeks, from Esso's reservoir. It is chlorinated to break-point, chemically treated for coagulation of impurities, allowed to settle, filtered and then delivered to the demineralisers. The plant is capable of producing 3,750 gal./min. of effluent essentially free of turbidity, colour, oil and organic matter.

The principal items of the primary water-treatment plant are the chlorination equipment, two vertical up-flow coagulating and clarifying units, four gravity filter units, which are constructed as integral parts of the coagulating and clarifying units, and the necessary auxiliary equipment consisting of pumps, chemical storage, feeding and mixing equipment. Automatic sludge removal is provided in the settling chambers. Each filter has automatic control to remove it from service, backwash it and return it to service. The filter bed material is anthracite.

The chlorination equipment consists of an automatic unit with a range of 100 : 1 and with a maximum capacity of 2,000 lb./24 hr. The two Cochrane

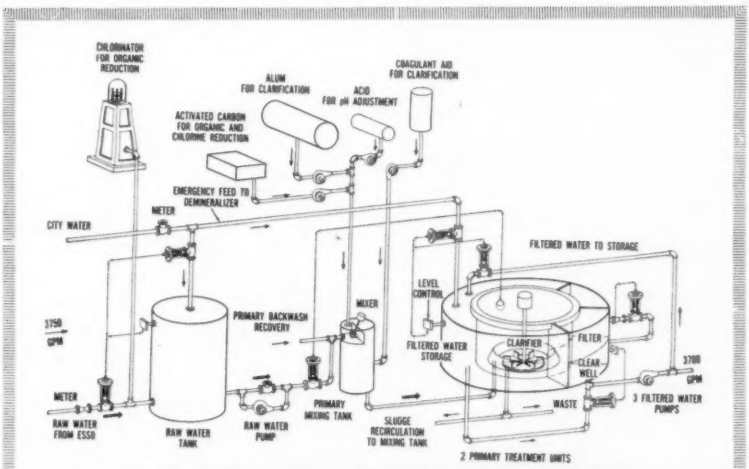
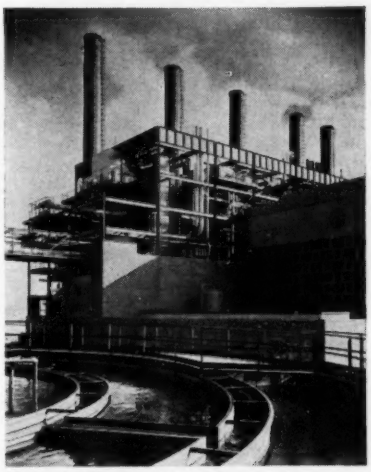


Diagram of the primary feedwater-treatment system.



Water-treatment plant in the foreground of the Linden power station.

complete coagulation and filtration units consist of two 62-ft.-diam. steel clarifiers, 18-ft. high, with 82-ft.-diam. concentric outer shells. Peripheral rings contain four 500-sq.ft. gravity filters, 251,000 gal. filtered water storage and 100,000 gal. backwash recovery storage.

The tanks used in the primary section include one 10,000-gal. mixing and dividing tank, two 11,800-gal., lead-lined-steel liquid alum storage tanks, one 1,000-gal., *Heresite*-lined sulphuric acid storage tank, two 1,700-gal. coagulating aid tanks and one 1,200-gal., rubber-lined-steel carbon feed tank. There are six ¼-h.p. *Rotadip* gravity-type mechanical units for handling liquid alum, acid, coagulant aid and activated carbon. Vertical propeller-type chemical mixing agitators are used as follows: one 7½-h.p. unit for the mixing and dividing tank, two 7½-h.p. units for the coagulating aid tanks, three 3-h.p. units for the carbon storage pit and two ¾-h.p. units for the carbon feed tank.

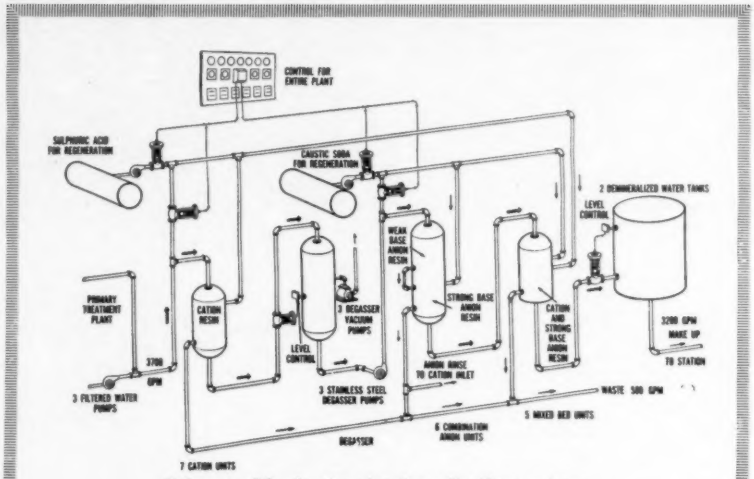
Demineralisation

In the demineralisation section, the water from the primary section flows

through cation units for removal of calcium, magnesium and sodium ions; through a vacuum degasser for removal of oxygen and carbon dioxide; through combination weak-base anion/strong-base anion units for removal of sulphite, chloride and nitrate ions and silica; and, finally, through mixed-bed units containing cation and strong-base anion resin for removal of trace impurities and then to storage. There are seven cation units, one vacuum degasser, six combination anion units, five mixed-bed units and two 500,000-gal. demineralised water storage tanks. All of the ion-exchange units, which are among the largest ever built, are 12 ft. in diameter. The quality of the effluent is specified not to exceed:

Total dissolved solids ..	0.2 p.p.m.
Dissolved silica	0.01 „
Total silica	0.02 „
Conductivity	0.5 microhms

Designed, initially, to produce continuously 3,200 gal./min. of water of guaranteed quality with an influent having a total dissolved solids content of approximately 300 p.p.m., the Cochrane demineralisation plant may be expanded in the future to 4,800 gal./min. capacity.



Scheme of feedwater demineralisation system.

Regeneration and control of the demineralisation equipment is also completely automatic and the entire water-treatment plant is designed to be run by two operators per shift.

Details of the ion-exchange units are as follows:

	Cation	*Combination anion*	*Mixed bed*
Number	7	6	5
Diameter, ft.	12	12	12
Straight height, ft.	15	15½	11
Design pressure, p.s.i.	75	125	125
Tank lining (rubber), in. ..	$\frac{3}{16}$	$\frac{3}{16}$	$\frac{3}{16}$
Resin capacity, cu.ft.	690	534—282	339—169
Resin type	IR-120	IR-45, IRA-401	IR-120, IRA-401
Maximum design flow, gal./min..	650	800	1,066

View of primary water-treatment plant, with refinery in background.

The Cochrane vacuum degasser is a three-stage unit, 14 ft. in diameter by 43 ft. 2½ in. in height, rubber-lined and with Raschig ring packing.

Pumping equipment is needed for no fewer than nine of the installations in the demineralising section of the plant.

The tanks used in the demineralisation section include three rubber-lined caustic soda storage tanks each of 13,600 gal. capacity, two 20,000-gal. sulphuric acid storage tanks, one 4,700-gal. rubber-lined cleaning reclaim tank, a rubber-lined resin reclaim tank and a caustic reclaim tank.

Plant and equipment suppliers

Chlorination equipment was manufactured by Wallace & Tiernan Inc.; coagulation and filtration units and tanks by Cochrane Corp.; agitators by Mixing Equipment Co.; while pumps are by Worthington, Aurora, LaBour, Taber, and Kinney Mfg. Div., N.Y. Air Brake Co.

ALLOY GATE VALVES

An advance in the design of their alloy gate valves which improves the shut-off power of the valve over much longer periods between maintenance, without the use of plastic, rubber or other non-metallic seatings, has been announced by Langley Alloys Ltd. The valves are thus still suitable for all duties for which the alloy of the valve is selected without temperature or other limitations.

This *Multi-seal* feature is obtained by specially machined faces on the gate of the valve, consisting of a series of concentric annular lands with grooves between.

Reduction of Uranium in Phosphoric Acid

By A. Flaschenberg, J. Lavi and J. Tulipman
(Israel Atomic Energy Commission)

The use of an electrolytic process for the reduction of uranium in phosphoric acid, as described by the authors at the 2nd United Nations International Conference on the Peaceful Uses of Atomic Energy, has been found to bring about a considerable saving in the cost of raw materials and equipment. The main points are summarised here.

THE phosphoric-acid solutions obtained from a plant producing this acid from rock phosphate and sulphuric acid have a redox potential of about –300 mv., measured by a calomel-platinum couple. Uranium is present in these solutions mainly in the hexavalent state. As solvent extraction processes generally apply to the extraction of tetravalent uranium[1], reduction of the solution to a redox potential of less than –180 mv. has to be included as a unit process prior to solvent extraction in a plant recovering uranium from such phosphoric-acid solutions.

Batch or continuous methods using iron scrap for the reduction process proved to have certain disadvantages. Large quantities of material, and presorting of the scrap in order to obtain a certain degree of homogeneity as regards particle size, are required for smooth and trouble-free operation, and subsequent filtration of the solution is also necessary to separate out the iron scrap.

The introduction of electrolytic methods disposed of the necessity of subsequent filtration and the handling of large quantities of iron. Problems arose, however, as regards choice of anode material from the point of view of corrosion resistance, mechanical strength and economy. Steel and copper alloys in various forms presenting high specific surface were tested as cathode materials. In the course of this work, copper alloys, stainless steel and iron employed as cathodes in various combinations of the materials yielded results that differed considerably from those typical of an electrolytic process, indicating that a different mechanism was operating. A galvanic process is postulated.

Theoretical considerations

The following mechanism for the reduction in phosphoric-acid solutions may be postulated:

The overall oxidation-reduction reaction in the solution is represented by

$$UO_2^{++} + 2Fe^{++} + 4H^+ \rightleftarrows U^{++++} + 2Fe^{+++} + 2H_2O$$

Pentavalent uranium is probably formed as an intermediary stage. The equilibrium is displaced to the right, *i.e.* reduction takes place, in highly acidic solutions.[2]

Trivalent ions may be formed (together with molecular hydrogen) when metallic iron is added to the phosphoric-acid solution—or by a disproportionation process from metallic iron and trivalent iron ions—this mechanism predominating in the electrolytic and galvanic processes in which metallic iron serves as electrode. A process of the latter type is economically preferable. In the first process, theory requires an infinitely large amount of iron for total reduction of all cations in the solution.

In practice, the theoretical quantity of ions required for the second type of formation of ferrous ions must be exceeded, however, secondary reactions with other cations taking place simultaneously. Copper may replace iron in either mechanism. One of the advantages of its use stems from the fact that the reduction of hexavalent to tetravalent uranium is accelerated by copper.[3]

It should be noted that care must be taken in designating systems as ' galvanic ' or ' electrolytic.' It is likely that in both cases iron dissolution is involved in the reduction mechanism.

' Galvanic ' reduction tests

As electrodes, iron, copper (or alloys of copper), stainless steel and platinum were used, the former two in equilibrium with their ions in solution, the stainless steel and platinum as inert metals acting as electron conductors.

An active (attackable) electrode of iron short-circuited with stainless steel or copper alloy, and an inert electrode of stainless steel or platinum, constitute a galvanic couple, with a potential difference between the electrodes of about 0.5 v. in 30% phosphoric acid.

Results and discussion

Preliminary experiments showed that the depth of immersion of the inert electrode did not influence the reduction rate. The latter, however, was increased by operating at higher temperatures (~25°C.).

Reduction-rate curves obtained employing iron stainless-steel electrodes of varying relative surface area display two characteristic tendencies: an initial slope roughly determined by the total iron surface area of the cathode, and a fairly well defined turning point, at which the slope begins to decrease, the value of the ordinate at this point being determined by the relative surface areas of the cathode constituents.

The optimum working curve, the criteria being maximum slope and lowest value of the reduction potential at which the turning point appears, is obtained with a 2 : 3 surface ratio of iron to stainless steel, and a total surface area of 4 to 6 sq. dm. of iron per litre of solution. Under these conditions a redox potential of –130 mv. was achieved in about 1 hr.

As regards the copper and brass electrodes, a similar additional mechanism as with iron takes part, copper dissolving in the acid and thus serving as a reducing agent, in accordance with the first mechanism outlined for iron.

This latter mechanism is illustrated in reduction-rate curves obtained employing brass wire mounted on copper and placed against a platinum electrode. The curve is seen to reach a plateau at a reduction potential of –150 mv. The reduction rate is dependent on the cathode surface area which determines the copper dissolution.

No such plateau is evident when copper is mounted on an iron frame and employed as electrode, reduction in this case being largely galvanic. The rate of reduction is determined by the relative surface areas of the materials.

In contrast to the curves obtained from iron stainless-steel electrodes, the reduction rate tends to be almost linear.

Despite the application of an external voltage to maintain the active electrode at a potential difference relative to the solution, dissolution of much copper took place in all the tests employing copper or copper alloy-iron electrodes. Because of such material losses, their use cannot compete economically with that of the iron stainless-steel.

Conclusions

The process studied has the following advantages over reduction of phosphoric acid by iron-scrap dissolution:

There is a considerable saving in iron consumption—about 0.5 g./l. being required as compared with 5 g./l. for the iron-scrap reduction method under the conditions of the experiments carried out in this study.

A smaller reaction vessel is required and, in general, equipment costs are cut down, since contact time is only one quarter to half that required for reduction by iron scrap. The acid at the end of reduction is clean, and no filtration or sedimentation is required. For a given cell the rate of reduction is constant.

REFERENCES

[1] D. A. Ellis, U.S.A.E.C. Report No. DOW-81 (1952).

[2] J. H. Pannell, R. J. Woody and J. M. Grandfield, *Ibid.*, No. MITG-248 (1951).

[3] J. Halpern and J. G. Smith, *Can. J. Chem.*, 1956, **34** (10), 1419-27.

£ s d

CHEMICAL PLANT COSTS

Cost indices for the month of August 1958 are as follows:

Plant Construction Index: 174.5
Equipment Cost Index: 164.1
(June 1949 = 100)

£ s d

Technology Notebook

Polarography in industry

The universal adoption of the polarographic technique for chemical analysis in the laboratory as well as continuous monitoring for plant control has been hampered in Britain by a general lack of appreciation of its possibilities, and by the absence of any central organisation of specialists able to provide practical training in all aspects of polarography, and capable of developing polarographic methods to suit the varied needs of industry. A decision has therefore been made to form a British Polarographic Research Institute for this purpose.

The Institute is arranging full- and part-time courses in polarography during the session commencing November 1958, and further particulars can be obtained from the Institute at 55 Oriental Road, Woking, Surrey. The secretary is Mr. W. J. Parker, B.SC., A.R.I.C., A.M.INST.F., A.M.INST.GAS E.

Mr. G. F. Reynolds, M.SC., F.R.I.C., Principal Scientific Officer, Chemical Inspectorate, Ministry of Supply, has accepted the chairmanship of the Institute's technical advisory panel.

Instrumentation of chemical plant

Special lecture courses at the Harrow Technical College for the current session include a series of 16 lectures on ' Chemical Plant Instrumentation and Automatic Process Control ' commencing on January 9, 1959, at 7 p.m.

Subjects to be covered include measurement of pressure, flow, liquid level, temperature, humidity, analysis, *p*H conductivity, specific gravity, CO_2 and O_2, automatic control and valves, data transmission systems, application and project development, and recent developments.

Fee for the course is £1 10s., and further details are available from The Principal, Harrow Technical College and School of Art, Station Road, Harrow, Middx.

Taming plutonium

Work began recently on the building of the Fuels Technology Centre at Argonne National Laboratory, U.S.A. One of the main aims will be to 'tame' plutonium for peaceful purposes. The centre is expected to enable Argonne scientists to speed up and expand their efforts to develop technology to permit the use of plutonium as a fuel in nuclear power reactors. These efforts will include the fabrication of fuel elements of various sizes and shapes for nuclear reactors.

Plutonium research is complicated by the fact that this element is intensely radioactive. Because plutonium is chemically toxic and a strong emitter of alpha particles, which create a health hazard, special facilities are necessary if it is to be handled safely. Such facilities are included in the plans for the centre, and account for a major part of its cost.

The Atomic Energy Commission has allocated 10 million dollars to Argonne to initiate construction of the Fuels Technology Centre.

Courses for senior engineers

The education committee of the Incorporated Plant Engineers announce that the next of their comprehensive refresher courses for senior works and plant engineers is to be held this winter at Liverpool University. It will comprise 18 weekly lectures on Thursday evenings and is to be opened on October 30 by Sir Oliver Lyle, O.B.E.

The syllabus covers the planning and control of maintenance, cost consciousness and the engineer, the application of new materials to plant engineering, properties and treatment of metals and alloys, developments in welding practice, lubrication, combustion, oil firing, steam utilisation, space heating, thermal insulation of industrial buildings, factory electrical systems, current techniques and future trends in the planning of plants and the operation of processes, materials handling, industrial accident prevention, communications and human relations, and the impact of automation on the plant engineer.

Full particulars may be obtained from the Secretary to the Refresher Course at the Donnan Laboratory, Vine Street, Liverpool 3.

Petroleum experts to see atomic plants

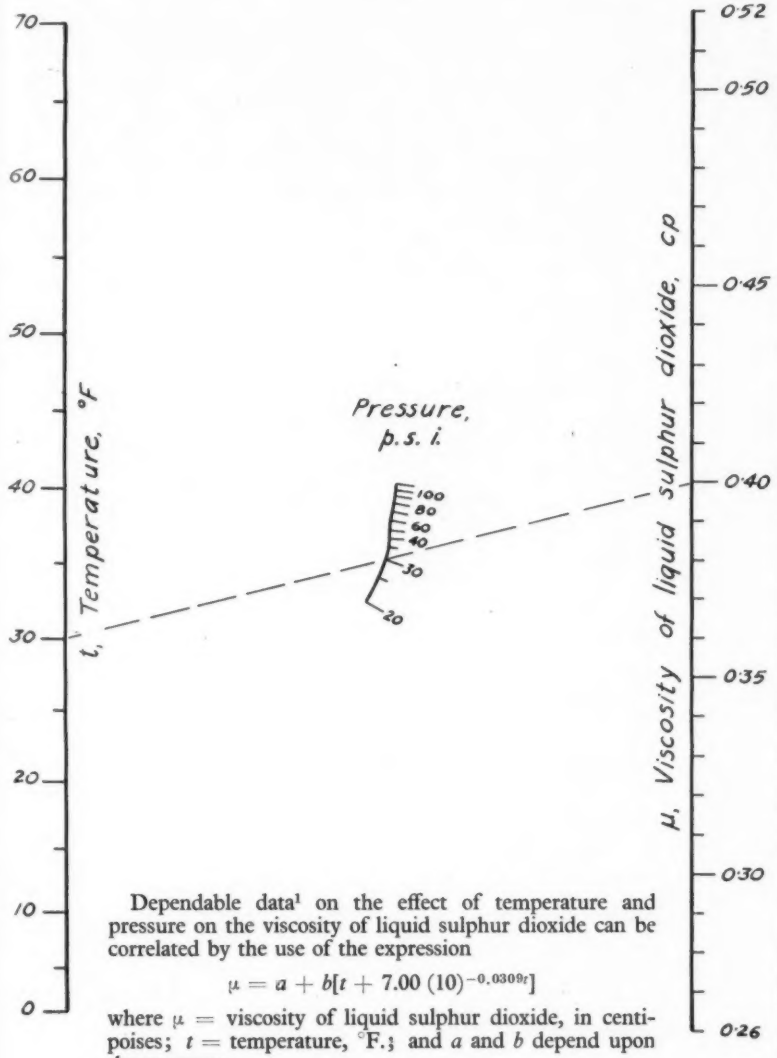
Official industrial tours being organised for delegates to the 5th World Petroleum Congress to be held in New York from May 30 to June 5, 1959, will include visits to the Brookhaven National Atomic Laboratory, Long Island, and to the atomic power station at Shippingport, Pennsylvania. These have a connection with the symposium on the uses of atomic energy in the oil industry which is part of the proceedings.

Nomogram:

Viscosity of Liquid Sulphur Dioxide

By D. S. Davis

(*Head, Department of Pulp and Paper Technology, University of Alabama*)



Dependable data[1] on the effect of temperature and pressure on the viscosity of liquid sulphur dioxide can be correlated by the use of the expression

$$\mu = a + b[t + 7.00\ (10)^{-0.0309t}]$$

where μ = viscosity of liquid sulphur dioxide, in centipoises; t = temperature, °F.; and a and b depend upon the pressure.

The use of the nomogram, which was constructed by means of well-known methods,[2] is illustrated as follows: At a pressure of 30 p.s.i., what is the viscosity of liquid sulphur dioxide at 30°F.? Connect 30 on the t-scale and 30 on the pressure scale with a straight line; read the desired viscosity as 0.40 cp. on the μ-scale.

REFERENCES

[1] 'Refrigerating Data Book,' p. 182. American Society of Refrigeration Engineers, New York, 1943.

[2] D. S. Davis, 'Nomography and Empirical Equations,' Chap. 10. Reinhold Publishing Corp., New York, 1955.

Radioisotopes and the Glass Industry

At a symposium arranged by the Society of Glass Technology, speakers from the glass industry and the Atomic Energy Research Establishment described uses of radioisotopes within the industry. Gamma-radiation techniques have special advantages in measuring the level of glass in, for example, glass furnaces and feeders where high temperatures render access difficult. Questions of accuracy, range and protection from possible radiation were discussed and it was suggested that the measuring apparatus could be adapted to form part of an automatic control loop. Reference was also made to other possible uses of penetrating radiation in the manufacture of glass containers.

The total quantity of selenium left in a glass after the addition of a decoloriser can be determined by irradiating in a nuclear reactor samples of the glass with and without the selenium additive. By comparing the resulting gamma-radiations with a differential type of scintillation spectrometer, selenium contents of 10 p.p.m. are readily determined. This use of inactive tracers revealed by radioactivation analysis is of wide potential application in production processes where radioactivity in the product has to be avoided.

The flow of glass in a number of tank furnaces has been investigated by adding a small amount of radioactive tracer to the glass melting batch and then measuring the amount of radioactivity in the glass containers produced. Details were given of the methods used for preparing and adding the tracer, consisting of a glass containing active phosphorus, and for measuring the activity of the glass samples.

Using tantalum as a non-radioactive tracer, both the rate of throughput and the degree of mixing in a glass-melting tank furnace have been assessed. After the addition of a small quantity of tantalum pentoxide to the glass batch, the relative amounts of tantalum appearing in the product can be determined by irradiating samples of the glass in a high flux of neutrons followed by the measurement of the activity induced in the tantalum present in the glass. Different amounts of sand labelled with an equilibrium mixture of ^{140}Ba and ^{140}La have been successfully used to trace the passage of sand through a sand-washing and grading plant and thence through a glass-melting tank furnace.

Contracts

Esso Petroleum Ltd., affiliate of Standard Oil (N.J.) has announced signing a contract with Foster Wheeler Ltd. for the construction of a 100,000-bbl./short-day 'grass-roots' refinery at the deep-water port of Milford Haven, South Wales. The $35-million plus refinery will be located on a 350-acre tract, formerly farm land. It will be served by a 3,500-ft. tanker jetty capable of accommodating 100,000-ton super-tankers.

The new refinery, along with the Esso refinery at Fawley, Hants (also built by Foster Wheeler and currently being expanded to 220,000 bbl./short day) is capable of supplying approximately 37% of Britain's domestic petroleum needs.

Cost of the refinery, tankage and deep-water-port facilities will be about $50 million. Present indications are that the refinery phase will take a little over two years to build and will employ a peak construction force of 2,000. Process design is being supplied by Esso Research & Engineering; Foster Wheeler Ltd. of London are performing the mechanical design, drafting, procurement and erection of all process units and most on-site and off-site facilities (excluding tankage and port facilities).

Process units include a 100,000-bbl./short-day atmospheric distillation unit including naphtha splitter and stabiliser; a 16,500 - bbl./short - day blocked operation powerformer; a 16,500-bbl./short-day gas oil hydrofiner; a 31,500-bbl./short-day gas oil drying unit (electric coalescer); and copper chloride sweetening facilities.

★

The Power-Gas Corp. Ltd. of Stockton-on-Tees has recently put into operation a Power-Gas/Hercules hydrogen plant which is incorporated in the new hardening plant at the *Stork* margarine works of Van den Berghs & Jurgens Ltd., Purfleet. This plant produces from propane feedstock a high-purity hydrogen containing less than 10 p.p.m. of carbon monoxide and this is used for hardening edible oils for the manufacture of margarine. Two stages of carbon monoxide conversion followed by carbon dioxide removal and a final methanation stage give the required purity of hydrogen. A Wiggins dry seal gasholder of 7,500 cu. ft. capacity stores the hydrogen.

★

Allen & Hanburys, an old-established British pharmaceutical house which already manufactures in many countries abroad, has won a contract to set up in Iran a £1-million factory to produce pharmaceutical products. The factory, measuring 180,000 sq. ft., will be sited 15 km. outside Teheran.

The contract is with the Imperial Welfare (Darou Pakhsh) Organisation, generally known as Darou Pakhsh, which provides the various welfare societies with free medical requisites for the underprivileged of Iran under the direct guidance of the Shahinshah.

Allen & Hanburys will provide design and layout for the plant, which will include control laboratories and stockrooms. They will also provide executive technical experts to run the factory who will come from Allen & Hanburys' British plants. A further condition of the contract is that Allen & Hanburys will set up a training scheme for Iranian students at their U.K. factory.

An essential part of the scheme is that the British company will have full technical control and the responsibility to maintain their normal high standards of production, which standards were a salient reason for the company gaining the contract.

★

Imperial Chemical Industries Ltd. is going ahead with a 30-million-lb. p.a. terephthalic acid plant which will approximately double present output and which is an element in the I.C.I. programme to extend its production of *Terylene* polyester fibre and *Melinex* polyester film. The plant is to be designed by Scientific Design Co. Inc. (U.S.A.) utilising a novel processing technique. Scientific Design will perform complete design and engineering service for I.C.I. in the United States, with liaison services in the United Kingdom. I.C.I. will construct the plant at their Wilton works with present total committed capital investment approaching £120 million. The latest *Terylene* extensions, announced in September 1957, will begin operations in 1960 and will raise the fibre-making capacity to 50 million lb. p.a.

★

An order in the region of $100,000 for a continuous hydrostatic pressure steriliser produced by the Food Machinery Division of Mitchell Engineering Ltd., of Peterborough, was recently shipped to Canada for the factory of an international canning company. Known as the *Hydron*, a machine of this type is capable of sterilising and cooking approximately 800 domestic-size cans of vegetables a minute. Powered by a 10-h.p. electric motor, the speed of processing and output can be remotely controlled by one man. It has a maximum working temperature of 262°F.

The unit incorporates entirely automatic feed-in and outlet control as well as numerous safety devices. It is 60 ft. tall and occupies a floor space 12 ft. square.

★

Fawcett Preston & Co. have received an order from Fabrika Kablova, Svetozarevo, Jugoslavia, for extrusion machinery worth just over £50,000. The machinery is for covering cables with plastic.

This is the second order Fawcetts—a member of the Metal Industries Group—have received from Jugoslavia's biggest cable factory. The first, announced last January, was valued at £25,000.

The Leonard Hill Technical Group—October

Articles appearing in some of our associate journals this month include:

Manufacturing Chemist — Air-conditioning in the Pharmaceutical Industry; Recent Developments in Gas Chromatography—1; Synthesis and Applications of Acyl Halides; Perfumes for Cosmetics—3, Lipsticks.

Corrosion Technology — Steels for the Petroleum Industry—1; Metal Spraying in Relation to the Corrosion Process; High-temperature H_2S Corrosion in Refinery Experience; Preparation of Steel Surfaces for Repainting.

Petroleum—Free Radical Reactions of Hydrocarbons in the Gas Phase; Protective Coating and Cathodic Protection in the Middle East; Cardon Refinery; Underground Storage for Liquefied Petroleum Gases.

Atomics — Geneva Conference; Progress in Thermonuclear Fusion; Industry's Powerful Tool—Radioactive Isotopes; Britain Insures the World's Reactors.

Food Manufacture — Corrosion Prevention in the Bottling Industry; Corrosion in the Food Industry; Corrosion-resistant Flooring at an Ice Cream Factory.

Dairy Engineering—Preview of the Dairy Show; Dairy Waste Disposal by Balanced Biochemical Bio-oxidation; Transport of Milk by Road.

Paint Manufacture—Conference on High Polymers, Nottingham; Aluminium—Versatile Pigment; Glycerol in Paints; Surface Coatings Derived from Tall Oil.

Automation Progress—Automatic Testing of Servo Mechanisms; Automatic Weighing; Digital Counting in Industry; Continuous Heat Treatment with Automatic Control.

WHAT'S NEWS about

★ Plant
★ Equipment
★ Materials
★ Processes

This illustrated report on recent developments is associated with a reader service that is operated free of charge by our Enquiry Bureau. Each item appearing in these pages has a reference number appended to it; to obtain more information, fill in the top postcard attached, giving the appropriate reference number(s), and post the card (no stamp required in the United Kingdom).

Self-sealing swivel joint

The *Hilyn* swivel joint is offered as a solution to the problem of reciprocating and rotary movement in rigid pipework where the use of flexible hoses is prohibited by original plant design or space restrictions. Self-sealing and pre-tension is achieved by the internal pressure with additional support from a specially tensioned spring which ensures that even at very low pressures the joint is completely pressure-tight. Automatic adjustment of pipework misalignment is possible through 360° with no restriction in flow. A 10° angular or side movement is also catered for. Simply constructed and incorporating only five component parts, the joint requires little or no manual adjustment.

Machined from B.S.S. gunmetal, it is suitable where steam, water, air, etc., is employed, although the joint can be manufactured in malleable iron, aluminium or stainless-steel alloys where gunmetal is not suitable. Available in elbow or straight patterns from ¼ to 2-in. B.S.P., sizes up to 6-in. B.S.P. can also be supplied to this design. A PTFE seal is standard to the range.

Self-sealing swivel joint.

It is stated that, subjected to test pressures exceeding 2,500 p.s.i., the joint has remained completely pressure-tight, although for normal industrial applications it can be used up to 500 p.s.i. and temperatures up to 485°F. For applications involving higher pressures and temperatures, special designs are available on request from the makers, Hilyn Industrial Equipment Ltd. **CPE 1011**

'Impact' grinding and pulverising

In the *Entoleter* mill particle size reduction is effected by impact, there being no frictional resistances between the particles under treatment, and materials subject to heat degradation can be successfully processed with negligible temperature increase. The machine has therefore a high mechanical efficiency, as practically all the available energy is expended in doing useful work. Makers: Henry Simon Ltd.

The essential mechanism of the mill is a high-speed rotor enclosed in a steel casing. This rotor is composed of two horizontal discs spaced about 1¼ in. apart. The steel casing is fitted with a removable liner carrying a close-set row of impact pins. As the rotor spins at a predetermined speed, the material under treatment is fed through inlet spouts to the centre of the rotor. Centrifugal force hurls the material outwards until it strikes and disintegrates against the row of impact pins. It then falls into the conical delivery hopper beneath the rotor and through the outlet spout. The degree of reduction is governed by the rotor speed—the faster the rotation the greater the impact.

Capacities of 200 to 500 lb./hr./h.p. are available, depending on the density of the material used and the degree of reduction required. Machines up to 40 h.p. are available, giving a maximum throughput of 20,000 lb./hr. **CPE 1012**

Enclosed conveyors for chemicals

The movement of granular or powdered solids is reduced to the practical simplicity of piping in the Redler *en masse* system. The material travels through closed circuits propelled by driving chains with closely spaced flights which distribute the pressure throughout the moving mass with no risk of crushing or clogging. Conveyor-elevators operate horizontally and vertically and around curves, flow rates are easily controlled, and feeding and discharge can take place at any point or points on the run.

The same makers, Redler Conveyors Ltd., have developed methods of extracting from bulk-storage silos and bunkers materials which are prone to arch and which will not gravity-flow under pressure. Steel storage bins equipped with circular bin discharges are built and supplied for a large number of different materials, including cement and many heavy chemicals. **CPE 1013**

Pipeline strainers

Strainers recently introduced by Lancaster & Tonge Ltd. include duplex strainers for removing foreign particles from water and other fluids where it is essential to ensure uninterrupted flow. A plug-valve-type strainer is made in a range of sizes from ¾ to 4 in. bore, and a gate-valve type is available in sizes from 6 to 24

in. bore. Both types are designed to ensure an extremely low pressure drop through the strainer, and they are provided with baskets giving an open area ratio of 6 to 1 in all cases.

The gate-type strainer is suitable for all fluid flow conditions where continuous flow and maximum capacity are essential, while the plug type provides a continuous flow of fluids, liquid, gas or vapour, and is suitable for installation under pressure or suction. The multiple basket type can be used for all fluid flow conditions where large capacity is required, and where the flow is continuous except for occasional shut-down. **CPE 1014**

Corrugated transparent Cobex

A 65-ft. tower was erected at the chemical works of F. W. Berk & Co. Ltd. to house a difficult remote-controlled chemical process. The tower is made of a steel angle frame with an outer sheath of corrugated, transparent *Cobex* sheet manufactured by BX Plastics Ltd. The sheeting is transparent amber in colour, thus adding an attractive appearance to outstanding corrosion resistance. The tower was erected to the design of F. W. Berk's own engineers. **CPE 1015**

Temperature and pressure controllers

Temperature and pressure controls for warm air, steam, and hot-water plants are available within a range of on-off and potentiometer-type modulating controllers by Honeywell-Brown Ltd.

The pressure controllers—covering the range 0 to 300 p.s.i.—are generally used as a direct controller of an automatic burner on steam- or vapour-heating plants. These pressure instruments can also be used to control the pressures of air, liquids, and non-combustible gases. Variation in pressure is detected by the controller's bellows which can either actuate a switch or, for fully proportioning control, move a sliding contact across a potentiometer coil to position a modulating motor.

The temperature controllers—0 to 700°F.—control temperatures in ducts, pipes, tanks, boilers, and heat exchangers. Temperature changes at the remote bulb are transmitted, as vapour pressure changes, by capilliary tubing to a bellows in the instrument. The movement of the bellows operates a switch or, for fully proportioning control, a potentiometer slider to position a modulating motor. **CPE 1016**

'Y'-cone blenders

The Apex 'Y'-cone blenders are designed for the rapid, economical blending of powders, pellets, granules or flakes. The blender consists of a conical portion, the smaller end of which provides the discharge opening. The larger cone end opens into two cylindrical portions mounted at approximately right-angles to each other. By a unique geometric construction, all internal surfaces blend into each other so that no corners or crevices occur. There are no internal baffles, bearings or mixing arms, so that 100% discharge and easy cleaning is obtained.

As the blender rotates, the material is lifted beyond the angle of repose and the free surface begins to slide so that the material is tumbled, rolled and folded. The plane of shear is always changing throughout the mass, whilst the moving material is continually being divided and recombined as it passes into and from the two legs of the blender.

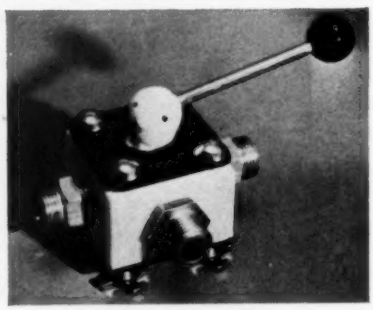
The sliding material is deflected by the inclined curved surfaces at constantly changing angles and so achieves the turnover in both the vertical and horizontal planes. This feature, it is claimed, results in homogeneous mixing in the minimum of time, with materials of varying particle size, shape or density. Further, this gentle action being free from attrition, does not break up fragile crystal shapes, does not result in any change of particle size, and does not generate any heat. **CPE 1017**

Fluid controls in PTFE

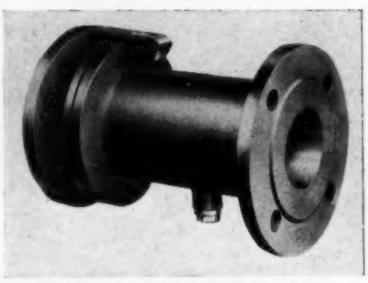
A new series of fluid control valves by the Watson-Marlow Air Pump Co. is designed to control combinations of direction, volume and pressure in the flow of fluid, acid, alkali or solvent except fluorine and molten alkali metals.

There are three types of valve, each having only one moving part and one material in the path of the fluid.

Both body and plug of these valves are machined from PTFE. They are held in position by two rigid clamping plates, tightened by four screws and none of these has any contact with the inside. There is an ample anti-friction ring, also in PTFE, between the front plate and the shoulder of the plug.



Fluid control valve.



Metal bellows expansion joint.

Thus all fluid contact parts and bearing surfaces are of solid PTFE. No lubricant or sealing compound of any kind is required, nor is there any lining or coating. The surfaces of the valves are non-wettable and non-adherent, every internal surface being a smooth, open curve.

The operating temperature range is from −50°F. to +450°F.

The working parts are slightly resilient, and the plug is held in compression instead of tension. One consequence of this slight resilience is that the valves will absorb considerable vibration, and can therefore be used to great advantage in glass pipelines.

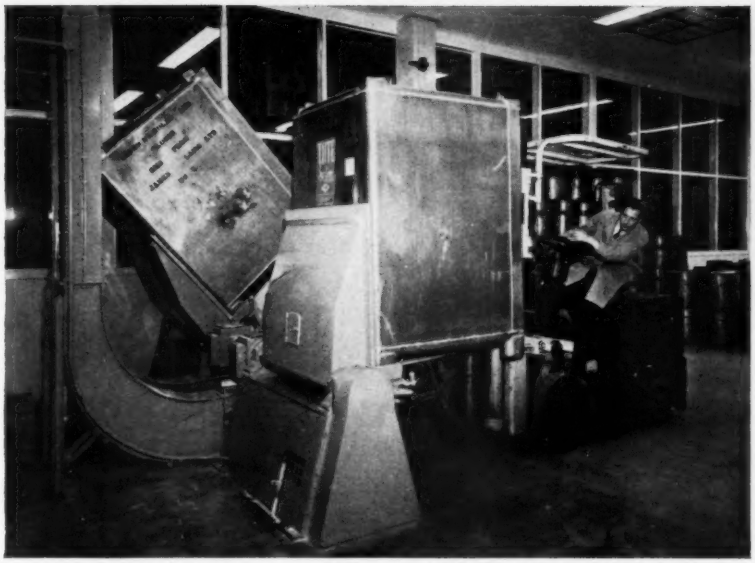
A complete range of pipes, adaptors and fittings has also been produced in PTFE. **CPE 1018**

Metal bellows expansion joints

Expansion joints are available which employ as a means of absorbing pipe expansion a metal bellows made from seamless drawn tube of high-copper bronze alloy. The joint is designed so that the steam, hot water or other medium flowing through the pipeline bears only on the external surface of the metal bellows.

This is achieved by the provision of an outer casing and an inner lining. Being connected at its ends to the extremities of both, thus surrounding one and being contained in the other, the metal bellows is guided in its length between the two, thus eliminating misalignment of the joint.

Features of these joints, which are made by Samson Controls Ltd., in-



Raw materials for 'Aspro' manufacture being tilt-discharged in unit loads.

clude automatic centering of the bellows due to even external compression, and frictionless movement of the bellows, as the medium being passed forms a cushion between the bellows and outer casing. The joint can be insulated in the same way as the pipeline because of its smooth and even surface. **CPE 1019**

PORTABLE PUMP FOR CORROSIVES

The *Chemix* portable pump unit is designed for the transference of corrosive fluids. The specially designed motor unit is a ½-h.p., totally-enclosed series wound universal motor, suitable for operation on 230 v., or 110 v. single-phase electrical supply, and operates at 3,000 r.p.m. Incorporated into the handle is a special contact switch, thus giving great ease of control to the operator.

It has a maximum capacity of 600 gal./hr. and a maximum lift of 15 ft. and when the head is reduced a capacity of over 600 gal. can be obtained. The immersion depth is 2 ft. and the gland unit is fitted with a special double seal. This seal and the motor-shaft coupling are housed just below the motor and are easily visible and accessible through the perspex guard. All parts in contact with the material are constructed in PVC. Makers are F. & R. M Harris (Birmingham) Ltd. **CPE 102**

New valve withstands chemical corrosion

A new valve in *Fluon* can be used with hot corrosive liquids and also with strong sulphuric acid, strong nitric acid and hot ferric chloride. It will withstand temperatures up to 200°C. and is claimed to be immune to corrosion by any known chemical.

The price for a ½-in. valve is about £35. It is one of a range of corrosion-resisting valves made by Chemical Pipe & Vessel Co. Ltd. up to 2-in. bore. They are available with flanged ends, and in some cases screwed ends for screwing into low-pressure lines. The range includes fine adjustment valves, pressure-relief valves, on- and off-valves, and non-return valves. **CPE 1021**

Sodium methoxide

A condensation agent and catalyst for a great number of chemical reactions, *Feldalat NM*, finds application in esterification and interestification reactions as well as in the formation of ethers in water-free media. It is also used in the manufacture of various dyes, pigments and intermediates, while it is an auxiliary for the manufacture of synthetic resins and plastic products.

Feldalat NM is sodium methoxide in the form of a fine, white, free-flowing, caustic, hygroscopic powder with a particle size of about 0.07 mm., thus allowing practically dust-free working. It is supplied in Britain, along with other alkoxides (alcoholates) by Tar Residuals Ltd. **CPE 1022**

Heavy-duty emulsifier

A heavy-duty homogenising and emulsifying machine for the production of high-grade homogeneous emulsions, solutions, mixtures, etc., has been produced by Elektro-Mischer Fortuna of Germany. This high-speed mixing and stirring machine is claimed to produce extremely fine particles and most homogeneous mixtures.

Owing to the mixing capacity and rate of flow, the size of the hopper is of no importance, since the material can be continuously fed. If large outputs are required, it is expedient to place above the hopper one or two large containers of a capacity each of 100 or 200 quarts or more, each container being fitted with a regulating cock. From these containers the different substances are fed to the hopper in the correct proportions, if necessary by means of tubes, and from the hopper they are sucked up and worked by the turbine. By return flow, a circulation of the mix is provided for between the turbine and the hopper.

The turbine casing and the patented turbine are made from cast *Silumin*, while the hopper is of pure aluminium. Among other purposes, it is claimed that the machine is suitable for dissolving, dispersing or extracting, mixing, homogenising and emulsifying and the dissolving and washing of gases. **CPE 1023**

Handling chemicals in unit loads

As a method of moving materials in bulk unit loads, the *Tote* system of bins and associated equipment offers a means of reducing labour and handling costs to a minimum in loading and unloading operations. At a recent demonstration at the Slough factory of Aspro-Nicholas Ltd., arranged by Pressoturn Ltd., the system was shown handling fine chemicals and starch for use in the manufacture of *Aspro* tablets. By the use of this system, Aspro-Nicholas have been able to achieve considerable savings in time and labour. There is a reduction in the price of the raw material due to savings made by the suppliers in packing materials and transport costs, while there is a reduction in unloading time, the *Tote* bin taking up less space per 100 lb. of raw material than the previous palletised loads. In addition, with the elimination of the 10-lb. bags it has assisted in reducing the number of process workers, as each bag had to be emptied by hand, whereas the *Tote* bin is unloaded mechanically.

The Aspro factory has a weekly

intake of some 10 tons of fine chemicals delivered from Monsanto Chemicals Ltd., Ruabon, and some two or three tons of starch from Messrs. James Laing & Son Ltd., Trafford Park, and in both cases *Tote* bins are carried by the suppliers' own road transport. Unloading is carried out by battery-electric fork-lift truck which moves the bins into a storage and quarantine area. After laboratory clearance, the material is delivered by fork truck to the manufacturing department, where the bin is placed on a screw-type tilt unit which is part of the system. When in position, the operator elevates the tilt unit to the discharge position by means of a motorised screw jack designed by Aspro-Nicholas engineers. The tilt screw flight motor is switched on, and the operator then opens the *Tote* bin door by inserting a key through the access door in the tilt unit hopper. The material is released into the screw flight from where it is delivered into the elevating system for incorporation in the product.

When the bin has been discharged, the tilt mechanism is lowered and the empty bin returned to the storage area where it is checked, sealed and reloaded on the road transport for return to the supplier's premises.

Tote bins are constructed in heavy-gauge, high-strength aluminium alloy and are made in three standard sizes. Units are available for handling both solid and liquid materials. Specially designed gaskets and fasteners exclude ingress of impurities and contamination, prevent loss of material from the bin, and retain the original moisture content of the material. **CPE 1024**

Probe is paddle in level control instrument

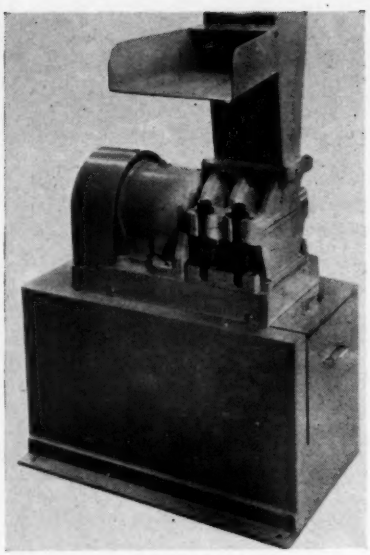
An instrument which will control the levels of liquids, solids and slurries and can be used for high- or low-point detection or proportional control over a narrow range is claimed to be based on a new principle. Automation Products Inc., U.S.A., are the makers of this instrument in which the probe is a paddle which vibrates at 120 c./sec.

Rated at 3,000 p.s.i., the instrument will work on 115 v. a.c., is flameproof, corrosion-resistant and can be mounted in any position. **CPE 1025**

Pretreatment for metals

A new product has been added to the range of chemical pretreatments for metals by Jenolite Ltd. This material, which can be brush applied, is claimed to be unaffected by climatic conditions, and will bond tenaciously to all ferrous and the majority of non-ferrous metals, particularly aluminium and its alloys, and zinc and/or zinc-coated surfaces. It is stated that it is unaffected by most solvents used in paint formulations.

When applied to descaled, derusted or even lightly rusted steel, the solution will yield excellent corrosion resistance. Stoving enamels can also be applied to a *Jenocote* surface and force-dried in a convection oven or by infra-red radiation. It is claimed that all types of cellulose, synthetics and enamels, bituminous coatings, epoxy coatings, etc., have been successfully applied over the solution to provide outstanding corrosion resistance under very hostile conditions. **CPE 1027**



PLASTIC GRANULATOR

The photo shows Burtonwood Engineering Co.'s model 1/2 granulator, which is described as being of sturdy construction, designed with short, robust shafts and heavy-duty bearings to accommodate the high shock loadings which may occur in the granulating of thick solid pieces of scrap rigid plastic. **CPE 1026**

Depth gauge for storage tanks

Recently redesigned to provide a more easily read dial, the *Clyde* depth gauge can be fitted to all kinds of bulk storage tanks. Maximum tank depth for the 6-in.-dial size is 6 ft. and, for the 10-in.-dial model, 10 ft. The makers are Buchanan Bros. Ltd. **CPE 1028**

Actuator for two-way remote control

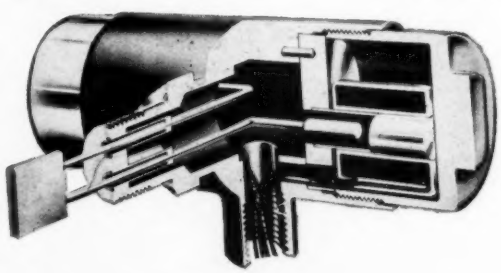
A cam gear which translates rotary motion in one direction only into successively reversed rotary motions also ensures that between each reverse motion the driven member is positively locked. The *Revlock*, produced by C. F. Taylor (Engineers) Ltd., does this without using any brakes, clutch or fine-limit switches.

In chemical and nuclear plants this device can be used for mixing machinery, valves, shutters, etc. Needing no attention, it can be used in awkward spots. **CPE 1029**

Dust and fume sampling

A production version of an iso-kinetic sampling apparatus for dust and fume sampling developed by the British Iron and Steel Research Association is being produced by Longworth Scientific Instrument Co. Ltd. Besides serving as a guide to grit, dust and fume-emission dangers, this equipment also has uses as an aid to production control. By measuring the flow rates and temperatures of gases, it can indicate the presence of air leaks and consequent waste of heat and fuel.

Main advantage of the equipment lies in the speed with which samples can be taken. The design of the filter assembly is such that changing the filter takes no more than about 10 sec. The units comprising the complete apparatus are housed separately, with flexible connections. There are a sampling probe, filter unit, cooling coil, pump units and instrument unit. In addition, a combined pitot tube and pyrometer is provided for measuring gas velocities and temperatures. **CPE 1030**



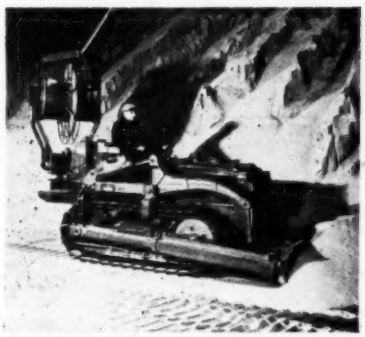
This level controller depends on the damping of vibrations imparted to the paddle probe.

Meters for liquids

The introduction of new American-designed equipment for industries processing water, oils and industrial liquids has been announced by Cleveland Meters Ltd. These *Auto-Stop* models offer batch and cycling controls that are completely automatic in operation once the controls are preset. Used in conjunction with special *Print-O-Register* equipment, the meters can issue tickets printed up to quadruplicate, showing the quantities delivered or dispensed. **CPE 1031**

Ventilation in fertiliser works

For a number of years Scottish Agricultural Industries Ltd. have used International Harvester BTD-6 *Bullgraders* to reclaim granulated compound fertilisers from storage bays. In their new project at Leith, they decided to install I.H. equipment in the compound storage building, although they were faced with the problem of operating a number of vehicles in an insulated and fully enclosed store where it would prove costly to ventilate exhaust gases. Electric motors powered by batteries



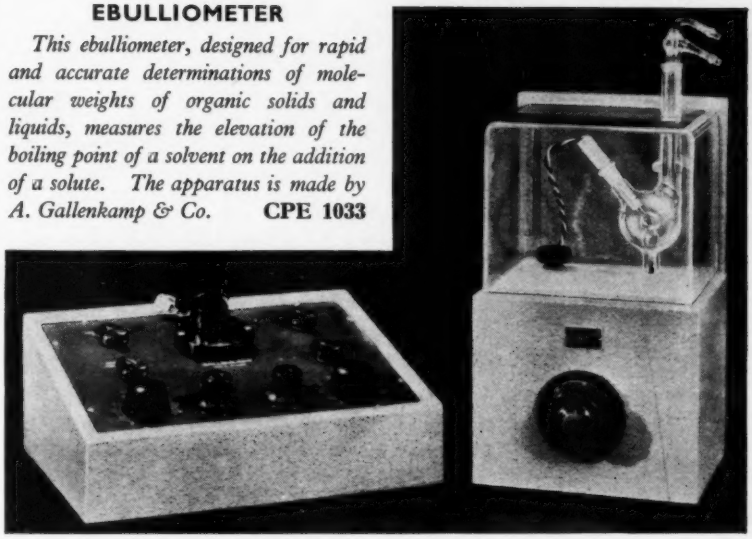
'Bullgrader,' incorporating totally-enclosed squirrel-cage motor, handling fertiliser at the S.A.I. factory, Leith.

were considered, but it was found that the difficulties in connection with battery chargers, etc., would be enormous.

Eventually, totally-enclosed 40-h.p. squirrel-cage motors were designed and supplied by Bruce Peebles & Co. Ltd. for incorporation in the unit frame in place of the usual diesel engine, and current supply is conveyed to the machine through the medium of a specially constructed *Deco* spring-controlled radial reeling drum, incorporating cable guide rollers and rotating sliprings giving complete control over the fertiliser bed. The tension in the reeling drum is sufficient to keep the cable clear of the heap so that there will be no hazardous working. **CPE 1032**

EBULLIOMETER

This ebulliometer, designed for rapid and accurate determinations of molecular weights of organic solids and liquids, measures the elevation of the boiling point of a solvent on the addition of a solute. The apparatus is made by A. Gallenkamp & Co. **CPE 1033**



Induction flowmeter

Manufacture in Britain of the *Altoflux* induction flowmeter has been announced. This instrument is suitable for the flow measurement of difficult liquids such as acid or alkaline slurries, pastes, sewage, abrasive mixtures, etc., and is being manufactured initially for pipeline up to 9 in., production to be extended in due course to diameters of several feet. These sizes are at present being dealt with by the associated organisation in Amsterdam, as are the *Altocon* instrument for the percentage measurement of concentration, and the *Altosol* instrument, the integrating equipment which, combined with the flowmeter, provides a measurement of the quantity of solid matter delivered.

Further details from Alto Instruments (Great Britain), or by using the reply-paid postcard. **CPE 1034**

Protective suit in PVC

A protective suit made with *Geon* PVC sheeting is now available and is useful for the inspection of plant where there is atmospheric contamination by toxic fumes, gases or dust. Designed primarily for use in the atomic energy field, the suit is claimed to give complete protection against radioactive dust while allowing maximum freedom of movement.

Special features of the suit, which has been introduced jointly by Spembly Ltd. and Plysu Products Ltd., include full ventilation to the body extremities and helmet air supply, both controlled by the wearer, while the weight of the air hose is taken by a special harness and there is unrestricted vision in all directions. **CPE 1035**

New PVC pastes

A range of PVC pastes known as *Plastisols* has been developed by Dunlop for a wide variety of industrial applications. They are basically dispersions of fine PVC powder in a liquid plasticiser, which under the influence of heat gel and solidify to a rubbery solid without appreciable loss of volume. They are particularly suitable for the casting of hollow toys in heated metal moulds and the coating, by means of a hot dipping technique, of metal articles such as draining baskets, wire trays and racks. Other uses include the backing of textiles and tufted carpets and the manufacture of coated papers. **CPE 1036**

PVC fume cabinet

Transparent, wire-reinforced rigid PVC is the material used by Turner & Brown Ltd. for an inexpensive, lightweight, press-moulded fume cabinet, which is made in four separate parts: top, back and sides, and two sash

runners; the sash cords are made of *Terylene* and run on PVC pulleys. The special type of PVC used gives a safeguard against warping at higher temperatures. **CPE 1037**

Giant plastic containers

A process for the production of polythene containers, etc., in sizes of up to 50-gal. capacity has been introduced in Britain by Tool Treatments (Chemicals) Ltd., in conjunction with a German company. The new casting process is inexpensive and makes short runs of 500 products to customers' own designs. **CPE 1038**

Mixing apparatus

Mixing apparatus available from Q.V.F. Ltd. consists of a vibration generator operating on alternating current, which vibrates the shaft at the same frequency, moving up and down in short, powerful strokes. A two-way switch alters the stroke length of the shaft, by which the mixing action can be increased or decreased as desired. *Vibromixers* are available in three sizes. Special sealing assemblies are designed for specific applications. **CPE 1039**

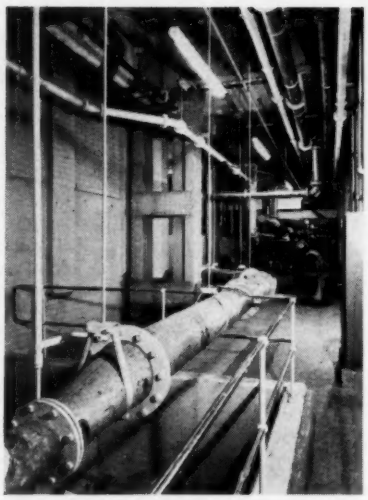
Lead alloy

To counteract a small but increasing number of inexplicable failures in chrome tank linings, British Lead Mills Ltd. have developed *Antatac R*1. This lead alloy is now available in the form of sheet for linings, pipe for heating and cooling coils, and anodes. **CPE 1040**

Smoke alarms

A simple smoke alarm, suitable for chimneys up to 10 ft. diam., and giving an alarm when the smoke passing up the stack exceeds a preset amount, is produced by A. M. Lock & Co. The control unit is housed in a dust-tight, cast-aluminium case, and can be mounted up to 100 ft. from the light projector and receiver units which are mounted on the stack in weather-proofed housings. Two alarm recorders are available for use with this unit—a spring-driven model which has a chart lasting 24 hr. and an electrically powered one in which the chart lasts seven days.

The same company offers equipment which provides for remote indication and recording of smoke density, as well as an alarm when dark smoke is emitted. Features include a completely interchangeable plug-in electronic chassis in the control unit, easily accessible terminal connection panel, and a dust-tight, cast-aluminium case. **CPE 1042**



'TERYLENE' PIPE SUPPORTS

In the Ellesmere Port mill of Bowater Paper Corp. Terylene *webbing straps are used for the suspension of slack pipes carrying a mixture of paper pulp and water. Some* 2,000 *of these strings, supplied by 'W' Ribbons Ltd., of Croydon, are used. The average length of each is about* 4 *ft.; the width is* 2 *in. and the breaking strength is* 10,000 *lb. The advantages of* Terylene *webbing are that, whilst more manageable and less expensive than metal supports, it has higher resistance to acids, moisture and abrasion than any natural fibre webbing.* **CPE 1041**

Actuator and power feed units

Electrically controlled air/hydraulic devices are available which provide linear power for industrial plant and machines with the economy and simplicity associated with pneumatic equipment, but are unique in that the traverse can be controlled with all the precision of a full electro-hydraulic system.

Both actuator and feed versions of these units by Numation Ltd. are similar in construction, and comprise in one co-axial form (*a*) an air power cylinder, (*b*) a hydraulic control cylinder and (*c*) hydraulic valve mechanism for stopping, releasing or metering the flow of fluid from one side of the hydraulic system to the other and thereby controlling the energy of the air cylinder. **CPE 1043**

Variable area flowmeter

To their range of flowmeters, Fischer & Porter Ltd. have added new *Purgerator* models, produced primarily for controlling the flow of gases and liquids at a constant rate for bubbler service applications and purging operations, as with corrosive service manometers, but which can be used for a variety of applications where a small flow-indicator is required. **CPE 1044**

New oil expeller

The new 'D'-type oil expeller of Rose, Downs & Thompson Ltd. has a capacity varying between 10 and 20 tons per 24 hr., depending upon the material to be pressed. When processing cottonseed meats, it has a capacity equivalent to 20 long tons of whole cottonseed per 24 hr.; on other seeds the single pressing capacity is between 12 and 15 long tons/24 hr. At these capacities, expeller cake with less than 4% residual oil content is obtained from many oil seeds.

The expeller is recommended for oil mills with a capacity of upwards of 10 tons/day. **CPE 1045**

★ American Developments in Brief ★

A new nylon compound for the extrusion of large shapes has been designed by Allied Chemical to meet the need of extruders for an ultra-high-melt viscosity material, being particularly suited for blow moulding of bottles and containers. **CPE 1046**

★ ★ ★

Equipment which can be used for pulverising materials ranging from soft, low-melting-point organic compounds to extremely hard and abrasive materials is claimed by Majac Inc. to be able to reduce material as coarse as $\frac{1}{4}$ in. to particles less than 2 to 3 microns. Two jets are used, directly opposed to each other, a system which is said to expose the material to the maximum kinetic energy. An integral but separately controlled classifier removes the fines as they are generated. **CPE 1047**

★ ★ ★

An all-aluminium, compression-type coupling by Corrosion Engineering Co. Inc. eliminates welding, threading, and modification of pipe ends, the rubber gasket permitting expansion adequate in most installations. **CPE 1048**

Recent British Patents

Eliminating oxides of nitrogen

The invention relates to the removal of gases, particularly oxides of nitrogen, from works effluent gases. These substances are objectionable, being detrimental to the animal and vegetable life in the vicinity, and arise from such reactions as nitration, oxidation, and the manufacture of nitric acid by the oxidation of ammonia.

The removal is accomplished by adding hydrogen to the waste gases and passing the mixture over a nickel catalyst supported on alumina at 250 to 850°C. The oxides of nitrogen are thereby reduced to nitrogen. Experimental results are tabulated and a diagram of plant is appended to the specification.—799,159, *E. I. du Pont de Nemours & Co. (U.S.A.).*

Catalysts suspension materials

Aliphatic saturated hydrocarbon mixtures are used as liquid media for the suspension of catalysts in the synthesis of polythene of molecular weight above 100,000 at pressures below 200 kg./sq.cm., and temperatures below about 100°C. The hydrocarbon fractions are sometimes those obtained from Fischer-Tropsch processes, with hydrogenation of unsaturated constituents. Such mixtures contain oxygenated compounds such as alcohols, esters, or acids. These must be removed, as they are detrimental to the polymerisation of ethylene in the presence of catalysts containing organometallic compounds. To effect their removal the hydrocarbon fraction is hydrogenated in the presence of a catalyst containing nickel, at 230 to 280°C., after which it is treated with solid aluminium chloride and filtered. —799,179, *Ruhrchemie A.G. (Germany).*

Rotary drum drier

Drying and/or calcining of powdered or granular materials in processes such as the manufacture of light or dense sodium carbonate is subject to the disadvantage of scaling of the heating surfaces of an indirectly heated rotary-drum drier. A drier heated by internal steam pipes cannot be fitted with chain, paddle, or ball scrapers. In such cases it has been proposed to mix the material to be dried with a proportion of that already dried, to reduce the average moisture content of the whole. This procedure has the drawback of decreased output and increased fuel consumption, and the present invention relates to an improvement therein.

The drier is divided into three zones, in the first of which moist material is mixed with recycled partially finished material from the second zone, in which the main drying and/or calcining takes place. The product then passes into the third zone where the process is completed. The apparatus is shown in a drawing appended to the specification.—799,251, *Solvay & Cie. (Belgium).*

Urea adducts in hydrocarbon separation

Urea forms solid crystalline adducts with hydrocarbons having straight or slightly branched chains of carbon atoms, but not with those of highly branched chains. Further, no adducts are formed with naphthenes or with aromatic hydrocarbons. This property is utilised in petroleum refining, the urea adducts being separated and decomposed to liberate the combined hydrocarbons. If, for the formation of the adducts, the urea is dissolved in water, or an alcohol, or mixture of water and alcohol, difficulties arise from the voluminous nature of the crystalline adducts and also from losses of urea by decomposition when the hydrocarbons are split off by heating. An alternative method is to use a suspension of urea in a non-solvent diluent, in the presence of an activator, *e.g.* methanol. The adduct formed and separated is heated to a temperature above the melting point of urea, the latter being separated in the liquid phase. In this case there is also some decomposition of urea.

It is now proposed to suspend the urea in a non-solvent diluent, such as butane, which does not form an adduct at the reaction temperature of adduction. Hydrocarbon feedstock is treated with the suspension. The adducts, separated by filtration, are thermally decomposed at a temperature below the melting point of urea, the latter being filtered off and re-used. The process is continuous, and is illustrated diagrammatically. —799,191, *The British Petroleum Co. Ltd.*

Plant for producing vaporisable metals

An apparatus has been devised by which easily vaporisable metals can be produced by reduction of their compounds. This apparatus, illustrated by a drawing, is heated by radiation, and is applicable to the production of magnesium, potassium, bismuth, etc., especially magnesium, the metals having boiling points from 400 to 2,000°C. at 10 mm. pressure. In principle, the metal is distilled off, leaving a non-volatile residue which is retained and serves as a support for new reaction material. The residue can be removed, when desired, from a grate on which it rests. The original material is spread into thin layers.

In the first of seven examples, 100 parts of burned dolomite, containing 38% of magnesium oxide and 21 parts of ferro-silicon of 75% silicon content, are heated, in the apparatus described, to 1,600°C. The yield of magnesium is 23 parts. The residue of 98 parts contains 90 parts of calcium orthosilicate and 8 parts of 33% ferro-silicon, which is recovered. The pressure in the apparatus is 0.1 to 100 mm. of mercury. The magnesium produced distils into the condenser.—799,195, *Knapsack-Griesheim A-G. (Germany).*

Removal of Friedel-Crafts catalysts from polymers

Catalysts of the Friedel-Crafts type, such as aluminium chloride, titanium tetrachloride, zirconium tetrachloride and the like, are frequently used for the polymerisation of unsaturated hydrocarbons, such as those derived from steam-cracked petroleum. It is known that some of the catalyst is, at the end of the polymerisation reaction, in actual combination with the product, and must be detached from the polymer molecules in order to ensure colour stability of the product. To accomplish this, various reagents have been used including alcohols, *e.g.* methanol or ethanol, and alkalis, *e.g.* caustic soda, but small amounts of chlorides still remain unattacked.

In the present patent, it is claimed that a more efficient removal of residual catalyst can be achieved by the use of a mixture of an alcohol, preferably iso-propyl alcohol, and aqueous ammonia, in which the polymeric resin is washed. The resulting product is stated to possess improved colour. A diagrammatic flowsheet is appended to the specification.—799,198, *Esso Research & Engineering Co. (U.S.A.).*

The foregoing abstracts are published by permission of the Controller of Her Majesty's Stationery Office. Copies of specifications can be obtained from the Patent Office, 25 Southampton Buildings, Chancery Lane, London, W.C.2, price 3s. 6d. each.

Industrial Publications

Chemical engineering services are the subject of an illustrated 24-page brochure issued by Metal Propellers Ltd., Croydon, Surrey. The index takes the form of a conventional process plant flow diagram with page references to the various items of equipment in stainless-steel fabrication work which does not fall into the main chapters, *i.e.* atomic-energy plant, strip lining of columns and vessels, highly-polished plant, precision sheet-metal work, etc. The stainless-steel data tables, previously issued separately, are included at the back.

Polythene plumbing. A catalogue has been produced as a guide to polythene tubes and fittings. Points of interest include: advantages of polythene for plumbing; main drainage in polythene; installation work; welding of polythene; chemical and physical data of polythene tubes and fittings. The catalogue, containing many tables and illustrations, is by the Chemical Pipe & Vessel Co. Ltd., Godstone Road, Kenley, Surrey.

Gas cleaning plant. An electrostatic precipitator which, it is claimed, can remove almost any suspended material, either liquid or solid, and undertakes fine cleaning of the gas in a blast furnace, is the subject of an illustrated leaflet issued by Head Wrightson Iron & Steel Works Engineering Ltd., Teesdale Iron Works, Thornaby-on-Tees.

Oil-resisting rubbers. A recent pamphlet describes the properties of the *Hycar* nitrile rubbers, together with their oil resistance, low-temperature flexibility, tension strength and hardness, weathering properties and service temperatures, resilience, resistance to compression set, and applications. The manufacturers are British Geon Ltd., Devonshire House, Piccadilly, London, W.1.

Safety equipment. A supplement to Catalogue No. 156, which illustrates and describes their range of safety goggles and face-shields, has been issued by Fleming Safety Equipment. A copy can be obtained from 146 Clerkenwell Road, London, E.C.1.

Pneumatic hoists and rams. A new 24-page brochure gives details, with illustrations, of hoists and rams manufactured by the Consolidated Pneumatic Tool Co. of 232 Dawes Road, London, S.W.6. Among the new models described in this brochure is the cushioned ram, a unit designed to eliminate harmful structural shocks associated with the handling of heavy loads.

Pressure seals, static and dynamic, are the subject of an illustrated brochure on *Bestobell* packings, including sizes, weights and sections, issued by Bell's Asbestos & Engineering Ltd., Bestobell Works, Slough, Bucks.

Wet dedusting. The design, performance and some fields of application of the wet deduster are described in a 20-page catalogue issued by Dallow Lambert & Co. Ltd., Thurmaston, Leicester, with many illustrations and diagrams of the different types.

Protective clothing. A booklet on the range of *Jeltek* PVC and waterproof garments, with details of a photostatic branding process which enables one's name, mark or emblem to be permanently emblazoned on any garment listed, has been issued by J. E. Lesser & Sons Ltd., Green Lane, Hounslow, Middlesex.

Fire protection devices are the subject of a booklet illustrating the range of sprinkler installations by Matthew Hall, Dorset Square, London, N.W.1.

Heating and cooling. A recent brochure deals with indirect heat-transfer systems, heat generators, distillation plant, jacketed vessels and various services offered by Hygrotherm Engineering Ltd., 5 Fitzhardinge Street, Portman Square, London, W.1.

Chemical group. The structure of the Albright & Wilson group of companies and the activities of some of the larger manufacturing companies within the group are described in a recent booklet, together with overseas operations, and the important expansion of the British chemical industry in the last decade or so. The publication is available from Albright & Wilson's group publicity department, 1 Knightsbridge Green, London, S.W.1.

Precision bellows for use in control mechanisms and pressure-sensitive devices where a very high degree of precision is required are described in a new brochure by Avica Equipment Ltd., Mark Road, Hemel Hempsted, Hertfordshire.

Electric furnace element. An illustrated leaflet on *Crusilite*, a new non-metallic element, which makes electrical heating of furnaces both economic and highly convenient, resulting in simplicity of furnace design, cleanliness and absence of flue gases, and which can be utilised in all temperature ranges up to 1,500°C., with a variety of applications and ranges of sizes, has been issued by the Morgan Crucible Co. Ltd., Battersea Church Road, London, S.W.11. The company have also published an explanatory leaflet describing their history and development. The leaflet lists their complete range of products and subsidiary and associated companies.

PVC resins. A suspension process for PVC resins, developed by Scientific Design Co. Inc., 2 Park Avenue, New York 16, N.Y., is described in an 8-page brochure, where photographs of four of the five operating plants are shown together with a flow sheet of the process.

Organic chemical reagents. A booklet, Monograph No. 34 (1958), has been issued by the analytical laboratories of Hopkin & Williams Ltd., Chadwell Heath, Essex, covering carmine as a reagent for boron.

New material of construction. A new glass-fibre-reinforced plastics material, *Keeglas*, has been developed recently and details were given in CHEMICAL & PROCESS ENGINEERING in July (page 264). The makers, Kestner Evaporator & Engineering Co. Ltd., have produced an illustrated pamphlet on the properties and applications of this material and copies are available from them at 5 Grosvenor Gardens, London, S.W.1.

Polythene glycols. A new, 54-page booklet describing the properties, applications, storage, specifications, and testing of *Carbowax* polythene glycols is now available from the chemicals department of the Union Carbide International Co., 30 East 42nd Street, New York 17, N.Y.

Chemical process research is the subject of an illustrated booklet issued by the Battelle Memorial Institute, 505 King Avenue, Columbus 1, Ohio. The scope of the Institute's services and resources are described, and several case histories illustrated.

Chelation. A booklet which provides an introduction and background to the subject of chelation, and briefly outlines the properties and uses of the *Metaquest* range of chelating agents, based on EDTA, is available from Whiffen & Sons Ltd., 95 Wigmore Street, London, W.1.

Company News

The formation of a new subsidiary company has been announced by Sir Clavering Fison, chairman of the Fison group of companies, at a meeting of representatives of the Canadian Press and Government held at Chesterford Park Research Station recently. Fisons (Canada) Ltd. was formed in July of this year, the directors of the company including Mr. A. Wormald (commercial director of Fisons Ltd. and chairman of Fisons Pest Control Ltd.), Mr. W. Abel-Smith (Fisons Ltd.) and Prof. A. W. A. Brown (University of Western Ontario).

The agricultural chemical department of the new Canadian company will be responsible for the development, promotion and marketing in Canada of the agricultural chemicals of Fisons Pest Control Ltd. and J. R. Geigy, S.A., of Switzerland.

Fisons' interests in Canada go back to 1930 and include investments in International Fertilizers Ltd. of Quebec and St. Johns, and Fine Chemicals of Canada Ltd., Toronto. In recent years a growing volume of export business has been built up by a subsidiary company, Benger Laboratories Ltd., through their Canadian branch in Toronto and by Fisons Pest Control Ltd.

*

An amalgamation has been effected between the Hydronyl Syndicate Ltd. and Weinreb & Randall Ltd. Mr. D. G. Randall has been appointed technical director of the Hydronyl Syndicate Ltd., Dr. R. Lessing, C.B.E., remains managing director and Mr. W. J. Browning, commercial director.

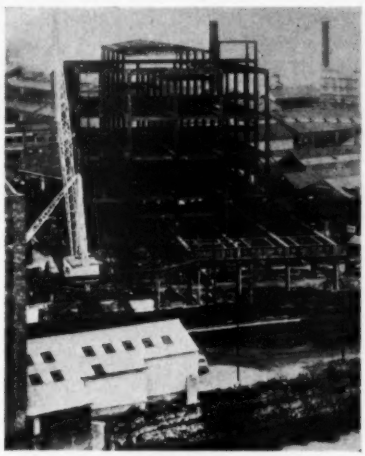
This reorganisation will enlarge the scope of their activities which hitherto have been mainly concerned with tower packings.

*

The Incandescent Heat Co. Ltd., Smethwick, have established a gas atmospheres division to co-ordinate design, development and sales of atmosphere generators, purifiers and gas driers.

*

A notable increase in exports of British chemical glassware is expected to be one of the first results of the fusing of the Jobling and Quickfit & Quartz groups. In a joint statement, Mr. J. A. Cochrane, deputy chairman and managing director of James A. Jobling & Co. Ltd., and Mr. B. H. Turpin, managing director of Quickfit & Quartz and of Q.V.F. Ltd., said that unique specialist skills formerly employed competitively would now blend to produce a marked improvement in the technical production of scientific glassware.



Going up—Crosfield's new building.

The joint statement follows the announcement that James A. Jobling & Co. Ltd., of Sunderland, manufacturers of *Pyrex*-brand glass, had purchased from Triplex Holdings Ltd. the entire share capital of the Quickfit group of companies, comprising Quickfit & Quartz Ltd., Q.V.F. Ltd., and Q.V.F. Glastechnik GmbH. of Wiesbaden, Germany.

The new comprehensive specialist organisation will be entirely devoted to serving the user of technical glassware.

*

A training school, to instruct customers' operators and maintenance staff in use of *Sunvic* pneumatic and electronic control instruments, has recently been opened by Sunvic Controls Ltd., at their Harlow, Essex, factory. Duration and content of the course is flexible, depending upon the degree of technical detail required by students, but it will not generally exceed one week. It will cover design, operation and applications of the pneumatic range of process control instruments, which are widely used in the oil and chemical industries.

The school, which has for some time been providing instruction in use of *Sunvic* multi-channel pulse height analysers, will be now administratively merged with the new process-control school, although courses will normally be quite separate.

Alfred Herbert Ltd., of Coventry, have been appointed sole selling agents in the United Kingdom and Eire for the planing machines and equipment manufactured by Planers (Huddersfield) Ltd. Whilst the wide range of standard machines includes double-column and open-side planers with many extras such as grinding heads, milling heads and profiling attachments and a range of unit head plano-milling machines, the company will consider any form of special-purpose reciprocating machine to meet specific requirements.

*

The foundation stone of the new chemicals building of Joseph Crosfield & Sons Ltd. at Warrington, Lancs., was laid recently, the ceremony being performed by Mr. R. E. Huffam, M.C., a director of Unilever Ltd., and a former director of Crosfield's. The new building, costing one-fifth of the total investment, will be in full operation by July of next year. It will concentrate initially on the manufacture of alkaline detergents and silica gel; one of the principal raw materials will be supplied from the silicate plant which was itself working under extreme pressure until the opening of a new plant at Bow in November, 1957.

*

Consolidating their venture into the South African market, made early in 1956, Birlec Ltd. announce that a Johannesburg branch office, under the management of Mr. S. G. King, has now been formed.

In November, 1955, Mr. King, formerly manager of Birlec's London Office, established an office in Johannesburg. There he acted in an advisory capacity to the B.T.H. Co. (S.A.) Pty. Ltd., who, for the interim period, were agents on behalf of Birlec. During the last two years excellent progress has been made.

*

Change of address

The chemical engineering division of the A.P.V. Co. Ltd., which remained at Wandsworth, London, when the head offices and works of the company moved to Crawley, Sussex, has now also been moved to Crawley.

Channel-belt conveyor

In our September issue (page 317) we published a photograph of a channel-belt conveyor handling two types of grain in two separate flows. This conveyor was manufactured by Rownsons (Conveyors) Ltd. and not by W. S. Barron as was stated. Our apologies to Messrs. Rownsons for this unfortunate error.

World News

FRANCE

New synthetic rubber plant

The first plant in France for the manufacture of styrene/butadiene rubber is to be built at Berre near Marseilles. Three companies will be concerned in this development, Shell St. Gobain (in which the Royal Dutch/Shell group of companies has a 60% interest), Michelin and Cabot-Texas Butadiene. The plant, with a capacity of 50,000 tons p.a., is to be situated in the vicinity of the Shell Berre refinery, the St. Gobain chemical plant and the Cabot carbon black plant, from which sources it will draw its raw material. Production is expected to begin in 1961 and this plant will be an important factor in lessening France's dependence on imported synthetic rubber.

UNITED STATES

New methylamines

A new plant for the manufacture of methylamines at the Wyandotte, Michigan, works of the Pennsalt Chemicals Corporation will produce mono-, di- and trimethylamine. It is claimed that, with the completion of this plant, Pennsalt, a major producer of organic nitrogen compounds, will be the only manufacturer of a complete line of the lower alkylamines from methyl through amyl.

NORWAY

Big aluminium deal

A business agreement involving £100 million worth of aluminium has been signed between the Norwegian State-owned Ardal & Sunndal Aluminium Works and Aluminium Union Ltd., a subsidiary of the Canadian concern, Aluminium Ltd. The latter is to deliver 4 million tons of aluminium oxide from its works in Jamaica —which will cover a substantial part of the Norwegian concern's requirements during the next 20 years. The raw material is to be paid for with the finished product aluminium. Ardal & Sunndal has a similar but less comprehensive contract with the Aluminium Co. of America.

CHINA

Still more chemical plants

Harbin is to become one of China's main chemical bases. According to reports, 31 chemical plants will go into construction this year and by 1962 there will be 65 large and medium-scale chemical plants. They will include a synthetic fibre plant with an annual output of 6,000 tons of caprone, a synthetic rubber plant with an annual output of 2 million tons and a chemical fertiliser plant with an annual output of 2,000 tons of plastic. In addition there will be two gas plants, and plants producing sulphuric acid, caustic soda and calcium.

Construction of a chemical fertiliser plant with an annual capacity of 800,000 tons of ammonium sulphate has begun in Hofei, Anhwei Province. All processes will be automatic and the first stage will be completed in 1960. A bacterial fertiliser plant has started production in Peking.

SOUTH AFRICA

New chemical engineering centre

To provide for the adequate training of chemical engineers, the University of Cape Town has planned a £20,000 chemical engineering block. The block, near the Fishing Industry Research Institute, is scheduled to be ready next year. At present there are 100 students at the university in various stages of the course and five postgraduate research students. Dr. A. D. Carr, senior lecturer in chemical engineering, pointed out that the three universities at Cape Town, Witwatersrand and Natal were turning out about 30 qualified chemical engineers annually as against about 5,000 p.a. in the United States. As industries developed in South Africa, however, the demand for chemical engineers would increase.

Recently a Students' Chemical Engineering Society had been formed to arrange vacation courses and to organise other special needs of the students.

PERU

Lead and zinc project

The Peruvian Government are shortly to install a pilot plant for the smelting of lead and zinc, which is intended to prepare the way for the setting up of full-scale smelters and refineries. The aim is to save foreign exchange and improve the position of the non-ferrous minerals industries, which have been suffering from the slump in prices, by exporting lead and zinc in metal rather than mineral form.

BRAZIL

Chemical expansion

The new factory of Bayer do Brasil Industria Quimica S.A. at Belfort Roxo in the State of Rio de Janeiro was inaugurated recently. It will produce aniline dyes, chemicals for the paper, textile and leather industries, and some basic pharmaceuticals, as well as insecticides, weed killers and other important chemical products hitherto imported.

BOLIVIA

Chemical industry

A Bolivian firm, Fasyd, is reported to be considering the establishment of a factory near Viacha for the production of sulphuric acid and derivatives. According to press reports, they have already planned to import the necessary plant and equipment and the total investment involved will be $150,000 (U.S.).

A new factory in Tarija was reported to have begun the production of iodine salt (for use in the treatment of goitre) with a capacity of 5,000 kg./day.

PAKISTAN

Fertiliser factory

The Pakistan Industrial Development Corp. and Kobe Steel Works of Japan have signed an agreement for setting up a fertiliser factory at Fenchuganj in the northern area of East Pakistan. The project is estimated to cost Rs. 15 crores, of which the foreign exchange component will be Rs. 11 crores, and completion is scheduled for July 1961. The factory will be based on the natural gas available at Sylhet, and is expected to produce 106,560 long tons of concentrated urea. In terms of standard fertilisers, however, the production will be 250,000 tons p.a. The agreement provides for deferred payment, 90% of the total cost to be paid in instalments spread over 3½ years after the commissioning of the factory.

Vegetable ghee plant

A first vegetable ghee plant is scheduled to go into production at Chittagong, East Pakistan, shortly under the name of the Hasnie Oil Mill. It will have a productive capacity of 10 tons/day of vegetable ghee, and will include pre-refining, hydrogenation, gas handling and storage, hydrogen production, post-refining, deodorising, polishing and ghee mixing and filling units. The factory will also have its own tin-making plant. The plant is designed to handle cotton seed oil, but it could equally well use other local oils, and the whole plant, including a boiler and laboratory equipment, is being supplied, erected and commissioned by a United Kingdom firm which also provided equipment for a neighbouring mustard oil extraction plant.

CEYLON

Cement project

A sum of Rs. 13 million has been set aside for the construction of a second cement factory at Puttalam. It is estimated that the total cost will be Rs. 38 million. Production at 125,000 tons p.a. will, it is hoped, commence in 1962. This, together with the proposed expansion of the Kankesanturai plant, should meet the island's cement needs of 325,000 tons p.a., which is the level estimated in 1962.

GREAT BRITAIN

New site for thermonuclear research

The Atomic Energy Authority propose to move the whole of the controlled thermonuclear project from Harwell to Winfrith Heath, Dorsetshire. The transfer will take place during the period 1961-63.

This change will permit the development of both fission and fusion work at Winfrith and allow room for whatever expansion of the latter is necessary in the future. It will also provide a margin for new work as yet unseen which will undoubtedly be developed at Harwell.

Winfrith Heath, near Dorchester, is a new site taken over by the Atomic Energy Authority. When first announced it was said that it would be a 'second Harwell' and that it would provide scope for work on reactor development. Development of the site started in September 1957 and one of the first projects is the construction of a high-temperature gas-cooled reactor.

DENMARK

Potash discovery

Unexpectedly large quantities of potash were found in samples obtained from oil borings in Jutland. A committee has been set up to study the possibility of mining it. Annual Danish imports of potash fertilisers amount to Kr. 60 to 70 million, and of soda and salt to Kr. 12 to 15 million.

New fibre factories

The government have agreed to recommend a State loan of Kr. 7 million towards the cost of a proposed factory to produce nylon and *Perlon* yarns in the Silkeborg area. The whole project is to cost Kr. 20 million. The remainder of its cost is to be met by a Swiss company investment of Kr. 4 million, a Danish investment of Kr. 3 million and by private loans. The factory is expected to employ 200 to 300 people. A fully automatic extension has been added to the Danish glass-fibre works in Kastrup, at a cost of Kr. 3 million, for the production of insulating material.

YUGOSLAVIA

Superphosphate factory's progress

The superphosphate factory at Prahovo, planned for a capacity of 550,000 tons p.a., is expected to have its trial run by the end of 1959 or at the latest during the spring of 1960.

MEXICO

Caustic soda production

The vast new caustic soda plant of Sosa de Mexico S.A. was recently inaugurated at Monterrey, the factory having cost 40 million pesos to construct. It is estimated that this factory will be able to produce annually 6,000 tons of caustic soda, 5,000 tons of liquid chlorine, 2,000 tons of hydrochloric acid and 1,000 tons of sodium hypochlorite, as well as certain quantities of carbon tetrachloride and chloroform. With this new plant Mexico will now be self-supporting in caustic soda.

NETHERLANDS

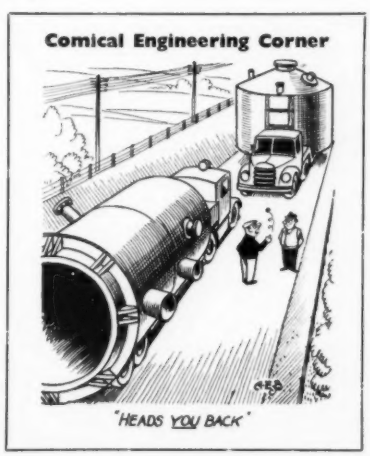
Cement mill

A fifth cement mill has been brought into operation on the site of the Hoogovens blast furnaces and steelworks at Ijmuiden. The new mill, which has a capacity of 35 tons/hr. and is one of the largest in Europe, raises the total output at the cement plant to 600,000 tons p.a.

DOMINICAN REPUBLIC

Nitric acid plant

A new plant to produce nitric acid has been inaugurated by the government technological services. It is stated to have cost RD. $150,000 and to have a productive capacity of 5 tons/day.



JAPAN

Oil refining

The new Showa Yokkaichi oil refinery, which is jointly owned by Showa Oil Co. (50% of whose shares are owned by the Shell Oil Co.) and Mitsubishi Oil Co., is capable of providing 40,000 bbl./day, but owing to the government's restrictions on imports of crude oil the refinery is reported to be operating at less than half its capacity.

WESTERN GERMANY

Aluminium and ferro-silicon

At the annual general meeting of Vereinigte Aluminium-Werke A.G., Germany, the directors reported that the company's plants produced 111,498 metric tons of virgin aluminium—an increase of approximately 7.4% compared with the previous year. The annual capacity of 120,000 tons, which had been restored in 1956, could no longer be utilised during the last few months of the year as a result of a falling off in demand. Business in ferro-silicon suffered under pressure during the year as a result of cheaper offers from the U.S.S.R. and other countries.

The annual output of ferro-silicon and silicon metal fell short of the figure reached during the previous year, since the plants involved needed an overhaul.

Waste sugar recovery

An interesting installation for the recovery of waste sugar is reported by Norris Bros. Ltd. Part of an existing process involved a deposit, largely in crystal form, of sugar on various vessels and items of equipment. When the process is complete this deposit is washed away to drain in the cleaning operation. The resultant liquid, of about 5% concentration, is of an unstable nature in that it will turn rancid in some 48 hr.

The installation is such that the dilute liquor is collected, filtered, and re-used in its original concentration and the system can now be maintained in a clear, fresh condition for a period of a week at the end of which the whole system is cleaned through. The primary feed of dry sugar is reduced in proportion to the concentration of the dilute liquor.

As the total quantity of dilute liquor exceeds the quantity which can be re-used, evaporation equipment is employed to raise the concentration of the liquor to a more stable condition (in this case 66° Brix) and is re-used as a concentrate.

Personal Paragraphs

★ Stockdale Engineering Ltd. announce the appointment of **Mr. I. MacLeod** as technical director. A mechanical engineer by training, his experience over the last 20 years has been mainly in chemical engineering. After early shop and design experience, he joined a prominent manufacturer of processing equipment and was responsible for the design and production of a range of colloid mills and mixing equipment. He then accepted the position of chief engineer to a company manufacturing similar equipment in the U.S.A. He has worked in other parts of the world, including Spain where he investigated markets and possible applications for process equipment. Latterly he has been with the Wilmington, U.S.A., engineering department of the Dupont Co., as consultant on the design and application of agitation and other types of fluid processing equipment. Mr. MacLeod will be devoting most of his energies at Stockdale Engineering to the development of their new range of agitation equipment and further strengthening their engineering services.

★ Ashmore, Benson, Pease & Co. have announced the appointments of **Mr. G. B. Taylor** as sales manager (works division); and **Mr. R. H. Foster** (works manager). Ashmore, Benson, Pease & Co. is a member of the Power-Gas Group.

★ **Mr. D. C. M. Salt** has been appointed to the newly-created post of general manager in charge of the chemicals division of Monsanto Chemicals Ltd., while **Mr. G. Dodd** takes up the corresponding post of general manager in charge of the plastics and special products division. Both general managers will be responsible to the managing director, **Mr. D. R. Mackie.** Mr. Mackie and **Dr. J. W. Barrett,** the company's technical director, who, as directors of the chemicals and plastics divisions, respectively, have been responsible since June 1957 for the successful initial establishment of divisional operations, are freed to concentrate upon their major company functions as a direct consequence of the new appointments.

★ **Dr. A. J. Hayter** has been appointed director in charge of the technical and sales division of Sharples Centrifuges Ltd. Dr. Hayter, who is transferring from an associated company, Sharples Chemical & Industrial Ltd., graduated in chemical engineering from University College, London. He carried out postgraduate work on high-efficiency distillation columns, with particular reference to water isotope separation. Prior to joining Sharples, he was engaged in the detergent, pharmaceutical and chemical engineering contracting industries. Since joining Sharples in 1954, he has been operating in the international field, and has travelled extensively throughout the world in the application of continuous process methods, particularly in the fields of edible oil, soap, fertiliser, and heavy chemical manufacture.

H. A. Holden.

A. J. Hayter.

I. MacLeod.

★ **Mr. G. Campbell** has been appointed general manager of the chemical and metallurgical division of the Plessey Co. Ltd. He was previously technical manager and deputy general manager of the company's Towcester plant.

★ **Mr. J. Higginbotham** has been appointed deputy general manager in the engineering department of Edgar Allen & Co. Ltd., after service in the accounts department and on the staff of the foundry manager. A senior member of the works' operational committee, Mr. Higginbotham became chief clerk of the engineering department in 1950, and in 1953 was appointed commercial manager, representing the company in the Middle East, Israel and Portugal in connection with cement plant contracts.

★ **Mr. W. M. Frames,** of Johannesburg, formerly chairman of Rand Mines Ltd., has been named chairman of the International Nickel Co. S.A. (Pty.) Ltd., South African subsidiary of the International Nickel Co. of Canada Ltd.

★ **Mr. W. L. Baker,** manager of the metal finishing division of the Pyrene Co. Ltd., retires after 30 years' service with the company. He will be succeeded by **Mr. H. A. Holden,** who has had many years' experience in the division. **Mr. H. F. Parshall,** who has been with the company for some 20 years, continues as director in charge of the division.

★ **Mr. R. E. Lapean** has been appointed regional director, Europe, of Cyanamid International. He has served for the past six years as managing director of Cyanamid of Great Britain Ltd. Coinciding with Mr. Lapean's appointment, Cyanamid has opened a new European regional office in Zurich at 48 Beethovenstrasse. Mr. S. C. Moody, director-general of Cyanamid International, states that it is not the company's intention to engage in basic chemical manufacturing in Europe, but rather to seek areas of demand for certain products, largely in the field of chemical specialities, which are developed in Cyanamid's own research laboratories. Previously Mr. Lapean served as a vice-president of Chemical Construction Corp., a former Cyanamid subsidiary with which he was associated for 14 years.

★ **Mr. A. P. M. Purdon** has been appointed operations study manager in charge of central operational research and work study for the British Oxygen Co. Ltd.

Clarification of coolants, used in grinding, either oil or aqueous, irrespective of whether the solid to be extracted is ferrous, non-ferrous or even non-metallic, is carried out by the *Turbomatic* centrifuge. Extracted solids are held in the high-capacity bowl, from which they are discharged once or twice a day by operating a reversing current switch, bringing the bowl to a standstill in 8 sec. This rapid braking action—which is not detrimental to the motor—coupled with the 45° inclination of the bowl, ensures immediate fall of the sludge without the assistance of any form of mechanical scraper.

It can also be used for many problems where a high degree of separation is required, coupled with simple sludge discharge. It is described and illustrated in leaflet No. 258 by the Alfa-Laval Co. Ltd., Great West Road, Brentford, Middlesex.